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An assessment of American Lobster (*Homarus americanus*) in Newfoundland in 2012

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

The American Lobster (*Homarus americanus*) is distributed near shore around the island of Newfoundland and along the Strait of Belle Isle portion of the Labrador coast. Major life history events (i.e., molting, mating, egg extrusion and hatching) generally take place during mid-July to mid-September, following the fishing season.

The fishery is localized and prosecuted from small open boats during an 8-10 week spring fishing season. Traps are set close to shore, at depths generally less than 20 m. Fishing effort is controlled through restrictive licensing and daily trap limits. Regulations prohibit the harvest of undersized (< 82.5 mm CL) and ovigerous (egg bearing) animals. In addition, there is a voluntary practice called V-notching, which involves cutting a shallow v-shaped notch in the tail fan of an ovigerous female. The mark is retained for 2-3 molts and v-notched females cannot be retained in the fishery. The practice thus serves to protect proven spawners even when they are not brooding eggs externally. The number of licenses is currently around 2,700 and trap limits range from 100 to 300 depending on the Lobster Fishing Area (LFA).

These stocks were last assessed in 2009 and are currently scheduled for assessment every three years. The present assessment of these stocks was requested by Fisheries Management to provide current information on the status of the resource and provide the data to be used in the updated Integrated Fisheries Management Plan (IFMP). Consequently, a Regional Peer Review (RPA) Process was held May 15-16, 2013. This document provides the methodology and analysis for the assessment of LFAs 3-14 which were assessed based on four regions that are a geographical grouping of the LFAs into the Northeast region (LFAs 3-6), Avalon region (LFAs 7-10), South Coast region (LFAs 11-12) and West Coast region (LFAs 13-14). The key indicators for the assessment are reported landings, nominal effort, catch per unit effort (CPUE), size frequency distributions and survival rate indicators based on molt class ratios.

The fishery has always been a recruit-based fishery, therefore reported landings reflect abundance. Most size frequency distributions clearly show a sharp drop at legal size and few lobsters achieving the second molt class, indicating that most of the exploitable biomass is caught in the year of recruitment to the fishery. Reported landings have been decreasing in the Northeast and Avalon Regions and increasing on the South and West Coasts. Total reported landings for Newfoundland have remained relatively stable since the 1960s. Reported landings increased by 70 % from 1,760 t in 2000 to 3,000 t in 2008 before declining by 28 % to 2,150 t in 2012 resulting from a decrease in the Northeast and Avalon regions and an increase in the South and West Coasts. The reported landings have become spatially concentrated. The contribution of the most productive LFA (LFA 11) to the reported landings has increased from less than 15 % in the early 1990s to around 45 % in the last three years. Nominal effort (based on active fishers, trap limits & fishing days) has decreased by 31 % since 2008, due to license retirements, fewer active fishers, shorter seasons, and trap limit reductions. Mean catch rates of pre-recruit lobsters show little annual variation and there is no apparent relationship between these catch rates and future commercial reported landings or CPUE. CPUE has changed little over the time period for which data are available (2004-12). Since 2008 the survival fraction has increased in all regions except for the Northeast region. Overall since 2004, the survival fraction was lowest in the South Coast region and highest in the Avalon region.

Évaluation du homard d'Amérique (*Homarus americanus*) à Terre-Neuve-et-Labrador en 2012

RÉSUMÉ

Le homard d'Amérique (*Homarus americanus*) est présent sur le littoral de l'île de Terre-Neuve et le long de la côte du Labrador, dans la portion du détroit de Belle Isle. Les principaux stades du cycle biologique (mue, accouplement, extrusion des œufs et éclosion) se déroulent généralement de la mi-juillet à la mi-septembre, après la saison de pêche.

La pêche est localisée et s'effectue à partir de petites embarcations non pontées au cours de la saison de pêche printanière qui dure de 8 à 10 semaines. Des casiers sont installés à proximité de la côte, à des profondeurs généralement inférieures à 20 m. L'effort de pêche est régi par des permis d'accès limité et des limites quotidiennes du nombre de casiers. Des règlements interdisent la prise des animaux de taille non réglementaire (LC < 82,5 mm) et des femelles œuvées (portant des œufs). En outre, les pêcheurs font, sur une base volontaire, une encoche en V peu profonde dans l'éventail caudal des femelles œuvées. Cette marque demeure visible pendant 2 ou 3 mues; les femelles ainsi marquées ne peuvent être conservées. Cette pratique sert donc à protéger les femelles reproductrices connues, même lorsqu'elles ne portent pas d'œufs. Le nombre de permis se situe actuellement autour de 2 700, et les limites du nombre de casiers varient entre 100 et 300 selon la zone de pêche du homard (ZPH).

Ces stocks ont été évalués pour la dernière fois en 2009 et font actuellement l'objet d'une évaluation tous les trois ans. La Gestion des pêches a demandé que soit effectuée la présente évaluation des stocks pour obtenir des renseignements actuels sur l'état de la ressource ainsi que des données qui serviront à mettre à jour le Plan de gestion intégrée des pêches (PGIP). Par conséquent, un processus régional d'examen par les pairs a eu lieu les 15 et 16 mai 2013. Le présent document décrit la méthodologie et l'analyse utilisées pour évaluer les ZPH 3 à 14. Cette évaluation a été effectuée en fonction des quatre régions qui sont un regroupement géographique des ZPH de la région du Nord-Est (ZPH 3 à 6), de la région d'Avalon (ZPH 7 à 10), de la région de la côte Sud (ZPH 11 et 12) et de la région de la côte Ouest (ZPH 13 et 14). Les indicateurs clés pour l'évaluation sont les débarquements déclarés, l'effort nominal, les prises par unité d'effort (CPUE), la répartition des fréquences de tailles et les indicateurs du taux de survie fondés sur les ratios des classes de mue.

Comme la pêche a toujours été basée sur le recrutement, les débarquements déclarés reflètent l'abondance de la ressource. La plupart des répartitions des fréquences de tailles montrent clairement une forte chute à la taille réglementaire et peu de homards atteignant la deuxième classe de mue, ce qui indique que la majorité de la biomasse exploitable est capturée dans l'année de recrutement à la pêche. Les débarquements déclarés sont en baisse dans les régions du Nord-Est et d'Avalon, mais en hausse dans les régions des côtes Sud et Ouest. Les débarquements totaux déclarés pour Terre-Neuve sont demeurés relativement stables depuis les années 1960. Les débarquements déclarés ont augmenté de 70 %, passant de 1 760 t en 2000 à 3 000 t en 2008, avant de subir une baisse de 28 % et de chuter à 2 150 t en 2012, entraînant une diminution dans les régions du Nord-Est et d'Avalon, et une augmentation dans les régions des côtes Sud et Ouest. Les débarquements déclarés sont maintenant concentrés dans l'espace. La contribution de la ZPH la plus productive (ZPH 11) aux débarquements déclarés a augmenté, passant de moins de 15 % au début des années 1990 à environ 45 % au cours des 3 dernières années. L'effort nominal (qui est fondé sur le nombre de pêcheurs actifs, les limites du nombre de casiers et les jours de pêche) a reculé de 31 % depuis 2008 en raison des retraits de permis, de la diminution du nombre de pêcheurs actifs, des saisons plus courtes et de la réduction des limites du nombre de casiers. Les taux moyens de prise de prérecrues

affichent très peu de variations annuelles et il n'y a pas de lien apparent entre ces taux de prise et les débarquements déclarés futurs des pêcheurs commerciaux ou les prises par unité d'effort. Les prises par unité d'effort ont peu changé au cours de la période pour laquelle des données sont disponibles (de 2004 à 2012). Depuis 2008, le taux de survie a augmenté dans toutes les régions sauf dans celle du Nord-Est. Dans l'ensemble, depuis 2004, le taux de survie est le plus faible dans la région de la côte Sud et le plus élevé dans la région d'Avalon.

BACKGROUND

SPECIES BIOLOGY

The American lobster, *Homarus americanus*, is a decapod crustacean characterized by a life cycle which is predominately benthic. Lobsters may live for more than 30 years (Lawton and Lavalli 1995). In Newfoundland waters, at the northern range of the species distribution, it takes about 8-10 years for a newly hatched lobster to reach the minimum legal size (MLS) of 82.5 mm carapace length (CL). Growth is achieved through molting, and frequency of molting decreases with increasing age. Growth is also affected by temperature, as molting probability tends to decrease with temperature (Fogarty 1989).

Molting and mating occur from July to September, and females extrude fertilized eggs approximately one year subsequent to mating. Ovigerous female lobsters carry the eggs in clutches on the underside of their tail, protecting and maintaining the eggs for 9-12 months. Thus, female lobsters are characterized by a biennial molt-reproductive cycle, though smaller mature females sometimes molt and spawn within the same year. At 1-2 mm below the MLS, about 50 % of females will extrude eggs during the spawning season. Fecundity of females increases exponentially with size. Eggs from larger lobsters tend to contain more energy per unit weight, and larger females tend to release larvae earlier in the season, potentially enhancing growth and survival (Attard and Hudon 1987).

Hatching occurs during a four month period extending from late May through most of September. Once released, the larvae swim upward and undergo a series of three molts during their 4-6 week planktonic phase, during which most mortality is thought to occur. With the third molt, a metamorphosis occurs and the newly developed postlarvae, which resemble miniature adults, are prepared to transition to the benthic environment (Factor 1995). Newly-settled lobster progress through several juvenile stages and an adolescent phase before reaching maturity.

The adult lobster is thought to have few natural predators and commercial harvesting accounts for most adult mortality. The diet typically consists of rock crab, lobster, polychaetes, molluscs, echinoderms, and various finfish.

THE FISHERY

The history of the American lobster fishery in Newfoundland dates back to the early 1870s. The fishery is prosecuted from small open boats during an 8-10 week spring fishing season. Traps are set close to shore, at depths generally less than 20 m. Reported landings peaked at almost 8,000 t in 1889 (Figure 1). Early documentation indicates that all lobsters captured were landed and processed by small canning operations that existed around the coast. A stock collapse occurred in the mid-1920s, after which the fishery was closed for three years, from 1925 to1927. The fishery reopened in 1928, and reported landings reached over 2,000 t, but dropped sharply the following year. In the early 1930s, shipment of live animals to markets in the United States (US) commenced, and regulations protecting undersize and ovigerous animals were strictly enforced. By the early 1950s, essentially all landed lobsters were shipped to the US, and the fishery has remained a live market industry since. Effort was largely uncontrolled up to 1976, at which point a limited entry licensing policy was implemented, and daily trap limits were regulated.

Following a 17 year period of general decline, to about 1,200 t in 1972, landings increased to about 2,600 t in 1979 (Figure 1). This trend was consistent with those of other Atlantic regions, and was attributed to a period of strong recruitment associated with persistent favorable environmental (i.e. temperature, salinity) and ecological factors which are still not fully understood. This general upward trend in Newfoundland landings continued through the 1980s. In January of 1986, a new geographical management system was introduced. Lobster fishing districts, which had been implemented around 1910, were replaced by Lobster Fishing Areas, or LFAs (Figure 2). A conversion to uniform trap limits, that differ by LFA was implemented for all LFAs between the late 1980s and early 1990s.

In 1995, the Fisheries Resource Conservation Council (FRCC) published "A conservation framework for Atlantic lobster". Within this report several conservation measures for increasing egg production and reducing exploitation rates were recommended, including an increase in MLS from 81 mm CL to 82.5 mm CL in the Newfoundland lobster fishery along with a maximum legal size restriction of 127 mm CL for the west coast LFAs (FRCC 1995). These measures were implemented over the course of the 1998-2002 management plan. In addition there was a 25 % reduction in lobster licenses in Newfoundland. Reductions in trap limits, season lengths and licenses issued were put in place as deemed necessary by fishery managers. In recent years, a Lobster Enterprise Retirement Program (LERP) and the Atlantic Lobster Sustainability Measures Program (ALSM) were implemented. Together these programs have led to license and trap limit reductions in the Newfoundland lobster fishery, particularly in the South and West Coast regions.

There are currently about 2,700 licenses with trap limits varying from 100 to 300 per licensed fisher (Table 1), depending on LFA. Traps must possess vents which allow undersized lobsters to escape. Regulations prohibit the retention of undersized animals, as well as ovigerous and v-notched females. V-notching, is a voluntary practice which involves cutting a shallow v-notch in the tail fan of an ovigerous female. The v-notch is retained for 2-3 molts and v-notched females cannot be retained in the fishery. The practice thus serves to protect proven spawners even when they are not brooding eggs externally.

Total reported landings for Newfoundland have remained relatively stable since the 1960s (Figure 1; Table 2). In recent years they have increased by 70 % from 1,760 t in 2000 to 3,000 t in 2008 before declining by 28 % to 2,150 t in 2012. In the Northeast and Avalon regions the landings have been decreasing while on the South and West Coasts they have been increasing. The reported landings have become spatially concentrated. The percent of total landings in LFA 11 have increased from less than 15 % in the early 1990s to around 45 % in the last three years. The greatest decline occurred in LFA 4 from about 750 t in the early 1990s to 140 t in 2012.

METHODOLOGY

This assessment was conducted on four assessment regions which are a geographical grouping of LFAs into the Northeast region (LFAs 3-6), Avalon region (LFAs 7-10), South Coast region (LFAs 11-12) and West Coast region (LFAs 13-14) (Figure 2) and are based on trends in landings. The data available for assessing lobster in Newfoundland is all fishery-dependent and each LFA/region has varying data sources and availability for each year.

Data sources include reported landings (provided by the Statistics Division, Policy and Economics Branch, Fisheries and Oceans Canada) which are available for each LFA and hence each region (Figure 3). Reported landings are based on purchase and sale slips and are underestimated by an unknown amount as they do not account for local sales, poaching, and handling mortalities that can occur prior to the sale of the catch. The extent of local sales, in particular, can be considerable and varies by location and year. Despite a level of underestimation, reported landings do reflect abundance to some extent since the lobster fishery is a recruit based fishery.

In addition, information provided by Fisheries Management, Fisheries and Oceans Canada (DFO) on the number of active licenses; season length and daily trap limits was used to calculate the nominal effort for each LFA. The Lobster fishery monitoring program provides other data sources including logbook data from index fishers which have been collected from 2004 to 2012 with representation from each LFA in most regions except for LFA 5 where the Eastport Marine Protected Area (MPA) is located and at sea sampling and logbook data has been collected since 1997-98, and in LFAs 11 and 14B where logbook data was collected from 1999 to 2001. At sea sampling data is collected by observers and available for select LFAs from 2004-12. It provides information on lengths, maturity, undersize etc. that are unavailable from any other data source. Mandatory logbooks were implemented in 2010 which were collected for all LFAs.

AT SEA SAMPLING

At sea sampling data from 2004-12 was utilized in the 2012 assessment. At sea sampling data has consistently been collected in the Northeast region (LFA 5 since 1998 and LFA 4B since 2004) and in the South Coast (LFA 11) and West Coast regions (LFAs 14A and 14B) since 2004 and Avalon region (LFA 10) since 2005 with data from additional LFAs available in 2004-05 and since 2009.

At sea sampling programs have employed observers who record daily catches onboard fisher's boats in specific locations around the province. Where possible, every trap is sampled and carapace lengths of all lobster, both commercial and non-commercial, are recorded (to the nearest mm). Lobster which measure the MLS of 82.5 mm CL are recorded as 83 mm CL. Animals are placed into one of seven categories to account for sex, and if female, reproductive status and presence or absence of a v-notch. This data is used to produce an index of population structure. The categories are as follows:

1) male;
2) female, non-ovigerous, no v-notch;
3) female, non-ovigerous, new v-notch;
4) female, non-ovigerous, old v-notch;
5) female, ovigerous, no v-notch;
6) female, ovigerous, new v-notch; and
7) female, ovigerous, old v-notch.

Population Structure

The at sea sampling data was used to generate and present information on the population structure including percentages of males, ovigerous females, old v-notched ovigerous females, non-ovigerous females and old v-notched non-ovigerous females as size frequencies by carapace length for each region.

Survival Fraction

At sea sampling data were used to determine the number of lobster in each molt class/size range, N_1 (number of animals in first molt class after reaching MLS) and N_2 (number of animals in second molt class) for both males and females within each region and to calculate the molt class ratio (N_2 / N_1) for each respective year, which in turn were used as an indicator of lobster survival (Tables 4-11). The size ranges for the two molt classes which are dependent on sex and location were based on growth information provided in Ennis et al. (1989) for the Northeast region, Ennis et al. (1986) for the Avalon region and South coast region, and Ennis et al. (1994) for the West coast region (Table 3). Also, the two molt classes/size ranges were outlined on the size frequency distributions based on sex and location.

FISHERY LOGBOOK DATA

Logbook data from index fishers were available from 2004 to 2012 for each region, with representation from most LFAs for most years (Table 12). Throughout the commercial lobster fishing season, these harvesters collect fishery information including number of legal size lobster, traps hauled, ovigerous females caught, and undersize males and females caught.

Mandatory logbooks were implemented in the Newfoundland lobster fishery starting in 2010. CPUEs were calculated from these and comparisons with index logbook data showed similar trends. The mandatory logbook data for 2012 was preliminary.

CPUE

Using both the index and mandatory logbook data within each region, CPUE (sum of lobster caught/sum of traps hauled) was calculated by day, month, year, for individual harvesters for each LFA. Mean CPUEs were calculated by year and CPUE plots were generated. CPUE was also calculated on a weekly basis to assess fishery performance throughout the season in each region for each year. In addition, weekly CPUEs were compared against the weekly cumulative catch, as reported in logbooks, to assess the performance of the fishery against the level of removals for each year. Mean CPUEs from index fishers logbooks and mandatory logbooks were compared.

A potential pre-recruit index was derived using data from modified traps, available from fishers participating in the index logbook program. The traps were modified to prevent the escape of pre-recruits. However, the modifications were not standardized until 2010, leading to uncertainty in the pre-2010 data.

V-notching

Index fisher logbook data was also used to generate plots displaying the percentage of v-notching of ovigerous females (number of ovigerous females v-notched/total ovigerous females) annually within each LFA (Table 13).

RESULTS AND DISCUSSION

POPULATION STRUCTURE

The size frequency distributions show a sharp drop in the relative abundance of lobsters once they reach the legal size. This indicates that most of the exploitable biomass is caught in the year of recruitment to the fishery.

Size compositions and catch rates are influenced by catchability. Environmental conditions soak time and changes in fishing gear can affect catchability (Miller 1990). Unlike the commercial component of the catch, which is removed after the first capture, sublegal lobsters could be captured multiple times during a fishing season, potentially biasing interpretation of size compositions.

SURVIVAL FRACTION

Since 2008 the survival fraction has increased in all regions except for the Northeast region. Since 2004 the survival fraction was lowest in the South Coast region and highest in the Avalon region (Figure 4).

At-sea sampling data were used to calculate molt class ratios, which were used as an indicator of lobster survival. If the set of legal-sized lobsters contains an increasing fraction that have molted again since reaching legal size (i.e. that are large enough that they are assumed to have molted) this could be evidence that the annual survival fraction is increasing. The fraction could also increase if the mean time between molts is decreasing or the change in size between successive molts is increasing. Of these possible changes, it may be that change in annual survival fraction is the most plausible.

Males and females differ in growth rates (Wilder 1953, Campbell 1983, Comeau and Savoie 2001) and there is a greater rate of catchability of males during the commercial season (Miller 1990,Tremblay and Smith 2001) likely due to the protection provided for ovigerous and v-notched females. Therefore they are subject to different rates of survival which was evident in all 4 regions where the annual estimates of survival for males were consistently lower than those obtained for females.

This index does not account for impacts of natural mortality, potential differences in intermolt periods between the recruit size group and larger sizes, and annual variations in recruitment. Natural mortality of adult lobster is not precisely known, but is generally assumed to be low (between 10-15 %) and relatively constant over time (Gendron and Gagnon 2001). Natural mortality can vary and is dependent upon habitat, predator abundance and lobster size (Tremblay et al. 2013).

Methods for inferring annual survival fractions from the size structure of legal lobsters have not been tested or calibrated. They depend on several “all other things being equal” assumptions, and the potential errors when all other things are not equal have not been investigated. Some of these assumptions include constant recruitment, constant fishing pressure and accurate molt increment estimates.

CPUE

The mean CPUE was calculated based on index fisher and mandatory logbook data. CPUE has changed little over the time period for which data are available (2004-12) for all regions. There are uncertainties around using CPUE as an index of abundance. There are problems of estimating local density and it is unclear how to integrate local concentrations over space and time. Trap density and competition can affect how well catch rates measure local densities. A decrease in the number of active fishers which have been seen in some regions through LERP will reduce gear competition and result in an increase in CPUE. In addition, CPUE is not standardized in that it does not account for variation in water temperatures which can affect catchability (McLeese and Wilder 1958, Miller 1990). Fishing practices may also vary between fishers where soak times and redistribution of traps can vary greatly, and it is not uncommon for many harvesters to reduce effort substantially in the final weeks of the lobster season. Also, many lobster harvesters hold licenses for other species (e.g. snow crab) and will adjust effort to permit harvest of these other species (Collins et al. 2009).

V-NOTCHING

Overall the percentage of v-notching ranged from 4-23 % (Table 13) with the lowest rate of v-notching in the South Coast region. V-notching of ovigerous female lobsters has been taking place annually since its initiation in the mid-1990s. There are no reliable accounts of the amount of v-notching taking place but it is believed to be less than 15 % and variable among areas. Data from mandatory logbooks may provide a reasonable representation when a longer time series becomes available. If there is a positive effect of v-notching on recruitment, it has not yet become clear.

There are studies demonstrating that large female lobsters produce more, viable eggs than do smaller females (Attard and Hudon 1987). Protecting these large females in the population is a reasonable step towards increasing egg production but it is unknown if egg supply is a limiting factor for future fishery recruitment. Furthermore, it is unknown where enhanced recruitment, if any, will occur relative to areas with high incidents of v-notching.

REGIONS

Since the early 1990s the reported landings of lobster have decreased in the Northeast and Avalon Regions while increasing in the South and West Coast regions. The highest landings were reported on the South Coast in LFA 11. Overall the nominal effort has decreased since 2008 in all regions likely due to fewer active fishers (licence retirements), shorter seasons, and trap limit reductions in some regions. The mean CPUE has changed little since 2004 in all regions except for the South Coast region where the CPUE increased slightly. The size frequency distributions for all regions show a sharp decline in the number of lobster surviving beyond MLS with some variation between regions which is discussed in detail below. Since 2008, the survival fraction has increased in all regions except the Northeast region. The indices described above are discussed in more detail below for each of the four regions.

Northeast Region (LFAs 3-6)

Reported landings have declined from about 750 t in the early 1990s to 140 t in 2012 (Figure 5). The greatest declines have occurred in LFA 4, where the landings have dropped from approximately 160 t in the late 1990s to 20 t in 2012, and in LFA 4B where the landings drastically declined from approximately 380 t in the early 1990s to about 40 t in 2012 (Figure 6). Meanwhile, nominal effort has decreased by 33% since 2008 due to fewer active fishers (Figure 5).

Mean CPUE has changed little since 2004 in all LFAs (Figure 7) except in LFA 3 where it reached the lowest rate of CPUE in the time series in 2011 and doubled in 2012. However, when observing the change in CPUE on a weekly basis, the largest decrease over the season was in 2012, where the CPUE started out at 0.4 and declined to 0.05 by the end of the season (Figure 8). This differs from other years where the CPUE remained relatively constant with only slight changes. Also, there is no difference in the trend between the mandatory and index logbook data over the last three years (Figure 7).

In relation to cumulative removals, in recent years (2010-12) the fishery has performed well while maintaining the same rate of CPUE with cumulative catch of up to 55,000 lobsters. This amount has doubled from a cumulative catch of approximately 25,000 lobsters between 2005 and 2009 (Figure 9).

The size frequency distributions for both males and females within this region show a decline at MLS (82.5 mm) (Figures 10 and 11) suggesting that even though the landings are low there is still high fishing pressure in this region and very few large lobsters are surviving beyond the MLS. Being a recruitment based fishery, this is to be expected. Specifically, when observing the size frequencies for females (Figure 11) there are signs that the conservation measures (ovigerous, v-notching) are effective as the small number of lobster that are surviving beyond

MLS and the second molt class (> 130 mm CL) in some cases represent the old v-notched (notched in previous years) and ovigerous females.

Lobster survival in this region (based on molt class ratio) doubled from approximately 0.2 in 2005 to 0.4 in 2008 for females, and from approximately 0.1 in 2005 to 0.2 in 2008 for males at which point it peaked and then gradually decreased to approximately 0.3 for females and 0.1 for males in 2012 (Figure 12). In 2004, the percent of v-notching was at its highest level in the time series (approximately 37 %) but then declined to less than 10 % by 2006, and has remained between 8 % and 13 % since (Figure 13).

Avalon Region (LFAs 7-10)

Reported landings have declined from about 460 t in the early 1990s to about 50 t in 2012 (Figure 14). The greatest declines have occurred in LFA 10, the most productive LFA in this region, with landings at 420 t in the early 1990s dropping to less than 40 t in 2012 (Figure 15). The other LFAs in this region have consistently maintained landings of less than 40 t since the early 1960s. Nominal effort has decreased by 46 % since 2008 due to fewer active fishers and shorter seasons (Figure 14).

Mean CPUE has changed little since 2005 in LFAs 8-10 whereas it has gradually increased in LFA 7 (Figure 16). The overall mean CPUE for all LFAs within this region, based on the index logbook and mandatory logbook data, depicts a slight increase since 2008 with similar trends shown by both data sources (Figure 16). When observed throughout the season the mean CPUE follows a similar trend each year, showing little change throughout the season (Figure 17). However, in the last two years there was a slightly higher CPUE earlier in the season which declined by the last week of the season. While this is a common trend for CPUE, it is possible to see a slight increase in catch rates during the latter part of the season under minimal effort which would explain why the levels of CPUE in some years are maintained throughout the fishing season.

When comparing the CPUE to cumulative catch, the fishery performed at its best in 2010 when it maintained the highest level of CPUE and had the highest amount of landings, with more than 40,000 lobsters (Figure 18). In 2011 and 2012 the CPUE declined slightly but still sustained relatively high landings of more than 30,000 lobsters.

As described for the Northeast region the size frequency distributions show a similar pattern for both males and females within the Avalon region with the old v-notched and ovigerous females being the only survivors beyond the second molt class (Figures 19 and 20). Also, based on observation of the sample sizes within each LFA in this region, LFA 10 has driven the size distribution patterns as the majority of the at sea sampling data was collected in this area.

Lobster survival (based on molt class ratio) gradually increased for females from approximately 0.2 in 2008 to 0.4 in 2011 before declining slightly. Similarly, results for males show survival rate of about 0.15 in 2008 to 0.34 in 2011, declining slightly in 2012 (Figure 21). Since 2006 the percent v-notching (based on the index logbook data) in this region has remained between 13 % and 23 % (Figure 22).

South Coast Region (LFAs 11-12)

Reported landings increased from about 400 t in the early 1990s to peak at 1,300 t in 2010. They decreased to 990 t in 2011 and then increased to 1,100 t in 2012 (Figure 23). Within this region LFA 11 which accounts for approximately 90 % of the landings had the greatest increase from 400 t in the early 1990s to approximately 1,150 t in 2010, with landings of close to 900 t in

2012 (Figure 24). Nominal effort has decreased by 23 % since 2008 due to license retirements, fewer active fishers, shorter seasons and trap limit reductions (Figure 23).

Mean CPUE has increased slightly since 2004 in both LFAs (Figure 24). When comparing the mean CPUE for the mandatory logbook data and index logbook data over the last few years they depict a very similar trend (Figure 25). Observations of the weekly change in catch rates (CPUE) show a standard trend of starting high early in the season and gradually decreasing by the end of the season (Figure 26).

In relation to cumulative removals, the overall fishery in this region has performed well, showing signs of recruitment in each consecutive year especially in the last few years where the landings have sustained high levels of up to 250,000 lobsters (Figure 27).

Within this region the size frequency distributions show a sharp drop in the frequency of both males and females at MLS and minimal if any survival of large lobsters including the ovigerous and/or v-notched females beyond the second molt class (Figures 28 and 29). This region has the highest landings in Newfoundland, and also the lowest percent v-notching (4-7 % since 2006) (Figure 31), therefore a low rate of survival beyond the second molt class is expected, as the number of ovigerous, and v-notched animals were minimal and there is a high rate of exploitation (Figure 28). This region has stronger fishing pressure compared to the Northeast and Avalon regions.

Lobster survival was lowest between 2005-08 based on molt class ratios for males and females (Figure 30). It increased in 2009 and declined gradually in 2011 before increasing sharply in 2012 to the highest level in the time series.

West Coast Region (LFAs 13-14)

Reported landings increased from about 750 t in 2000 to 1,400 t in 2008 before declining to about 770 t in 2011 and increasing to about 880 t in 2012 (Figure 32). In recent years the landings in each of the LFAs of this region have declined with LFA 13A showing the highest landings of approximately 260 t in 2012 (Figure 33). Nominal effort has decreased by 29 % since 2008 due to license retirements, fewer active fishers, and trap limit reductions (Figure 32).

Mean CPUE has varied without trend since 2004 in all LFAs with the highest mean CPUE in LFA 13 (Figure 34). Observations of the weekly change in CPUE shows that it started high early in the season for most years and gradually declined to a lower CPUE by the end of the season. However in 2010 and 2012, after declining at mid-season the CPUE increased again by the last week (Figure 35).

In relation to cumulative removals, the fishery in this region has performed well overall and similar to other regions one of the best years was 2010. There are signs of recruitment in each consecutive year, especially in the last few years where the landings reached levels up to 150,000 (Figure 36).

There was an increase in CPUE from 2004 to 2006 after which it oscillated around 0.5 lobsters/trap through to 2012. Although the two logbook series had similar trends, the mandatory logbook CPUE was less than the index logbook CPUE over the last few years (Figure 34). This is the only region where this difference was noted.

Similar to the South coast region the size frequency distributions also show a sharp decline at MLS in the West Coast region which suggests minimal survival of the larger lobsters including ovigerous and/or v-notched females (Figures 37 and 38). Based on these observations this region also seems to have high fishing pressure with high landings and good recruitment.

Since 2009, lobster survival (based on molt class ratio) has gradually increased for both males and females, with a sharper increase for females than males (0.4 vs 0.26, respectively) in 2012 (Figure 39). Since 2006, the percent v-notching has remained between 8 % and 12 % (Figure 40).

CONCLUSIONS

Each year the catch consists largely of new recruits. Preliminary analysis of mean catch rates of pre-recruit lobsters suggests little annual variation and there is no apparent relationship between these catch rates and future commercial reported landings or CPUE. The reported landings have become spatially concentrated. The contribution of the most productive LFA (LFA 11) to the reported landings has increased from less than 15 % in the early 1990s to around 45 % in the last three years. Since 2004, the survival fraction was lowest in the South Coast region where the fishery has been very strong, and highest in the Avalon region where landings have been minimal. Nominal effort has decreased by 31 % since 2008 and, based on data limitations, there is uncertainty in calculating nominal effort for earlier years. The population structure in each region showed a low number of larger animals which depicts a recruit based fishery with high exploitation.

While long term trends in landings are believed to reflect abundance, there is uncertainty in inferring year-to-year changes in abundance based on landings. Landings are affected by changes in fishing effort and survival. Furthermore, reported landings do not account for local sales, poaching, and handling mortalities. The extent of local sales, in particular, can be considerable and varies by location and year. The assessment is based solely on fishery-dependent data and the time series from logbooks and at sea sampling are short (maximum 8-9 years). Given the near shore distribution of the Newfoundland lobster, it is difficult to assess all LFAs without a localized monitoring program in all areas where active lobster fishing occurs. In order to cover all areas, sampling would have to be expanded. At a minimum, sustaining at sea sampling within each of the 4 regions is crucial for providing information on the population structure. In addition, obtaining a longer time series of data collection, through the mandatory logbook program, will help contribute to effectively assessing the fishery for all LFAs.

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APPENDIX I - TABLES

Table 1. Daily trap limits per licensed fisher, by LFA in 2012.

LFA	Number of Traps
3	200
4A	200
4B	200
5	150
6	100
7	150
8	100
9A	200
9B	100
10	200
11	185
12	135
13A	180
13B	220
14A	250
14B	250
14C	300

Table 2. Reported landings (tonnes) for each LFA from 1960-2012.

Year	LFA 4A	LFA 4B	LFA 5	LFA 6	LFA 7	LFA 8	LFA 9	LFA 10	LFA 11	LFA 12	LFA 13A	LFA 13B	LFA 14A	LFA 14BC
1960	-	-	184	36	14	0	22	147	-	-	133	224	264	-
1961	-	-	222	33	16	0	18	99	-	-	104	201	223	-
1962	-	-	168	28	19	0	12	125	-	-	98	214	302	-
1963	-	-	197	34	19	1	16	125	-	-	101	317	335	-
1964	-	-	157	34	14	0	19	168	-	-	86	281	352	-
1965	-	-	194	26	28	1	21	99	-	-	123	285	278	-
1966	-	-	212	35	16	1	20	93	-	-	97	211	254	-
1967	-	-	239	21	16	1	14	62	-	-	120	239	253	-
1968	-	-	267	23	12	1	12	48	-	-	199	305	339	-
1969	-	-	131	38	19	6	21	64	-	-	237	277	264	-
1970	-	-	104	31	19	4	20	52	-	-	242	269	224	-
1971	-	-	70	26	19	5	18	47	-	-	278	227	219	-
1972	-	-	46	18	26	3	10	50	-	-	239	199	196	-
1973	-	-	82	16	22	7	6	88	-	-	153	180	237	-
1974	-	-	49	13	23	12	9	209	-	-	132	199	250	-
1975	-	-	81	16	22	13	9	268	-	-	103	158	273	-
1976	83	297	102	16	34	13	8	391	343	8	139	206	371	239
1977	134	342	128	13	19	8	10	358	344	5	150	165	317	188
1978	188	493	170	11	20	1	17	333	396	4	146	140	345	298
1979	221	352	172	17	20	11	23	411	477	10	202	162	321	193
1980	223	343	138	19	15	6	20	360	481	9	164	160	277	235
1981	209	356	162	30	22	5	20	293	347	7	171	196	290	265
1982	170	288	126	15	13	5	14	191	351	4	136	182	298	223
1983	179	316	159	23	42	8	14	273	412	17	168	211	322	254
1984	165	331	144	20	23	2	11	308	365	26	155	170	352	357
1985	200	372	159	30	26	5	12	347	360	36	186	303	441	434
1986	156	309	130	33	33	6	18	322	347	38	179	243	369	362
1987	166	248	100	21	28	4	11	305	295	26	168	226	326	277
1988	173	328	107	19	21	4	16	328	345	28	188	292	367	281
1989	161	378	118	16	26	5	17	332	386	43	243	403	413	575
1990	194	381	135	17	17	3	13	328	335	33	296	377	408	379
1991	167	372	163	21	16	2	14	409	436	13	289	377	465	330
1992	159	355	168	34	16	3	17	427	500	44	248	394	503	333
1993	122	213	105	25	29	6	9	289	530	28	324	328	385	228
1994	124	251	133	30	33	4	3	281	492	49	328	236	382	286
1995	128	213	136	26	18	2	5	311	457	44	307	238	343	316

Table 2. Reported landings (tonnes) for each LFA from 1960-2012 (Continued).

Year	LFA 4A	LFA 4B	LFA 5	LFA 6	LFA 7	LFA 8	LFA 9	LFA 10	LFA 11	LFA 12	LFA 13A	LFA 13B	LFA 14A	LFA 14BC
1996	133	198	132	23	16	1	5	227	463	27	288	230	335	299
1997	136	172	111	15	11	1	1	173	444	19	281	217	292	307
1998	141	151	115	19	10	1	3	166	517	25	228	217	218	232
1999	107	142	123	26	9	1	0	141	471	25	183	186	199	205
2000	106	122	100	18	7	1	0	107	530	17	184	215	174	180
2001	129	146	92	18	8	1	4	114	595	25	236	282	266	248
2002	114	90	96	18	6	1	6	112	651	11	258	286	234	170
2003	114	91	85	20	7	1	3	86	700	22	308	362	242	210
2004	88	69	56	10	5	0	2	63	717	13	263	297	169	158
2005	102	106	85	16	7	1	2	68	920	29	354	393	280	247
2006	82	74	78	20	10	1	2	69	983	48	352	427	295	199
2007	63	56	58	19	6	0	0	38	972	94	336	414	294	214
2008	47	87	78	24	7	0	0	44	1127	153	406	430	324	243
2009	47	60	68	22	8	0	0	53	1018	127	358	315	244	177
2010	39	57	74	27	10	0	0	60	1168	139	333	302	216	169
2011	24	37	54	11	10	0	0	35	882	112	254	221	171	123
2012	20	46	59	12	13	0	0	35	925	164	262	242	201	170

*Table 3. Growth information (N_1 and N_2 size ranges/molt classes) for males and females from representative LFAs within each respective region.**

Growth information locations	Size Ranges	Males	Females
LFA 5	N_1	83-95 mm	83-92 mm
LFA 5	N_2	96-109 mm	93-102 mm
LFA 10	N_1	83-95 mm	83-92 mm
LFA 10	N_2	96-110mm	93-101 mm
LFA 14 B	N_1	83-94 mm	83-91 mm
LFA 14 B	N_2	95-108 mm	92-101 mm

*References: Ennis et al. 1989 for LFA 5; Ennis et. al 1986 for LFA 10; Ennis et.al. 1994 for LFA 14B.

Table 4. Number of lobster in each molt class (N_1 and N_2) and the molt class ratio for males in the Northeast Region.

Year	**N_1**	**N_2**	**Molt Class Ratio- Males**
2004	6684	990	0.15
2005	575	53	0.092
2006	222	25	0.11
2007	213	29	0.14
2008	1093	228	0.21
2009	1012	187	0.19
2010	1106	200	0.18
2011	865	131	0.15
2012	704	84	0.12

Table 5. Number of lobster in each molt class (N_1 and N_2) and the molt class ratio for females in the Northeast Region.

Year	**N_1**	**N_2**	**Molt Class Ratio- Females**
2004	9206	2874	0.31
2005	689	159	0.23
2006	261	80	0.31
2007	233	73	0.31
2008	1023	426	0.42
2009	1051	400	0.38
2010	1346	453	0.34
2011	1014	309	0.30
2012	964	282	0.29

Table 6. Number of lobster in each molt class (N_1 and N_2) and the molt class ratio for males in the Avalon Region.

Year	**N_1**	**N_2**	**Molt Class Ratio- Males**
2005	200	53	0.27
2006	467	76	0.16
2007	767	91	0.12
2008	1141	157	0.14
2009	983	215	0.22
2010	875	239	0.27
2011	627	212	0.34
2012	626	179	0.29

Table 7. Number of lobster in each molt class (N_1 and N_2) and the molt class ratio for females in the Avalon Region.

Year	N_1	N_2	Molt Class Ratio- Females
2005	292	134	0.46
2006	794	291	0.36
2007	699	300	0.43
2008	1296	275	0.21
2009	1080	349	0.32
2010	841	312	0.37
2011	739	313	0.42
2012	870	334	0.38

Table 8. Number of lobster in each molt class (N_1 and N_2) and the molt class ratio for males in the South Coast Region.

Year	N_1	N_2	Molt Class Ratio- Males
2004	1605	89	0.06
2005	805	29	0.04
2006	2339	76	0.03
2007	2179	68	0.03
2008	2870	121	0.04
2009	2768	276	0.10
2010	2967	259	0.09
2011	2867	205	0.07
2012	2936	565	0.19

Table 9. Number of lobster in each molt class (N_1 and N_2) and the molt class ratio for females in the South Coast Region.

Year	N_1	N_2	Molt Class Ratio- Females
2004	1608	273	0.17
2005	772	89	0.12
2006	2348	255	0.11
2007	1943	175	0.09
2008	3171	269	0.09
2009	3222	609	0.19
2010	3386	676	0.2
2011	3514	599	0.17
2012	3890	1035	0.27

Table 10. Number of lobster in each molt class (N_1 and N_2) and the molt class ratio for males in the West Coast Region.

Year	N_1	N_2	Molt Class Ratio- Males
2004	2576	238	0.09
2005	2108	272	0.13
2006	2503	250	0.10
2007	2459	259	0.11
2008	1787	175	0.10
2009	1195	138	0.12
2010	2984	428	0.14
2011	1316	275	0.21
2012	2496	656	0.26

Table 11. Number of lobster in each molt class (N_1 and N_2) and the molt class ratio for females in the West Coast Region.

Year	N_1	N_2	Molt Class Ratio- Females
2004	3153	784	0.25
2005	1767	434	0.24
2006	2629	782	0.3
2007	1984	384	0.19
2008	2334	453	0.19
2009	1844	360	0.19
2010	3727	761	0.20
2011	2009	455	0.27
2012	3233	1307	0.4

Table 12.The number of index and mandatory logbook returns in the Newfoundland American Lobster Fishery (Entries were omitted in several locations due to a small fishery and/or small number of returns).

LFA	Logbook Type	2004	2005	2006	2007	2008	2009	2010	2011	2012
3	Mandatory	-	-	-	-	-	-	14	18	10
4A	Index Fishers	-	8	-	-	12	12	20	11	11
4A	Mandatory	-	-	-	-	-	-	158	119	38
4B	Index Fishers	14	16	14	15	-	-	30	33	33
4B	Mandatory	-	-	-	-	-	-	204	209	99
5	Index Fishers	6	-	10	9	11	8	13	12	13
5	Mandatory	-	-	-	-	-	-	177	129	79
6	Index Fishers	7	-	6	7	8	9	20	17	16
6	Mandatory	-	-	-	-	-	-	152	122	71
7	Index Fishers	-	6	6	7	7	7	13	10	12
7	Mandatory	-	-	-	-	-	-	70	55	31
8	Mandatory	-	-	-	-	-	-	29	23	16
9	Index Fishers	-	6	7	6	6	-	-	-	-
9	Mandatory	-	-	-	-	-	-	16	9	7
10	Index Fishers	-	12	24	21	21	23	32	30	27
10	Mandatory	-	-	-	-	-	-	164	127	71
11	Index Fishers	-	13	18	15	20	22	34	33	32
11	Mandatory	-	-	-	-	-	-	303	210	126
12	Index Fishers	-	-	7	7	7	8	8	8	7
12	Mandatory	-	-	-	-	-	-	43	38	31
13A	Index Fishers	-	-	-	-	-	-	7	6	8
13A	Mandatory	-	-	-	-	-	-	132	94	28
13B	Index Fishers	-	-	8	8	-	-	7	6	-
13B	Mandatory	-	-	-	-	-	-	147	104	56
14A	Index Fishers	-	-	8	6	6	8	19	17	17
14A	Mandatory	-	-	-	-	-	-	172	131	71
14B	Index Fishers	6	6	11	11	7	12	21	19	19
14B	Mandatory	-	-	-	-	-	-	154	132	68

Table 13: Percentage of V-Notched lobsters (based on the index fisher logbooks) during the Newfoundland Lobster fishery from 2004-2012.

LFA	2004	2005	2006	2007	2008	2009	2010	2011	2012
4A	-	15.28	3.90	-	9.34	6.40	3.35	5.01	2.03
4B	32.60	-	8.64	-	2.98	7.10	13.16	9.36	7.07
5	23.64	25.28	4.89	14.57	19.44	22.05	10.80	5.25	8.53
6	-	-	17.91	13.40	15.66	17.05	22.98	11.01	11.28
7	-	-	22.19	17.02	26.83	21.65	25.16	26.12	19.79
8	-	-	34.13	38.32	47.97	35.44	20.50	17.54	17.30
9A	-	-	17.12	-	40.47	20.63	18.09	25.48	24.26
9B	-	-	24.81	-	-	-	-	-	-
10	-	-	8.88	15.36	19.64	10.79	11.28	14.25	14.07
11	-	-	5.52	6.93	4.62	4.12	6.39	4.00	4.29
12	-	-	-	8.27	7.35	9.43	8.48	3.04	2.21
13A	-	-	-	21.18	10.23	5.37	10.70	12.27	3.95
13B	-	-	-	5.44	5.31	12.54	12.70	11.12	16.85
14A	-	-	-	-	4.37	7.66	9.55	9.08	9.30
14B	-	-	-	-	25.61	22.04	15.48	10.93	10.63

APPENDIX II - FIGURES

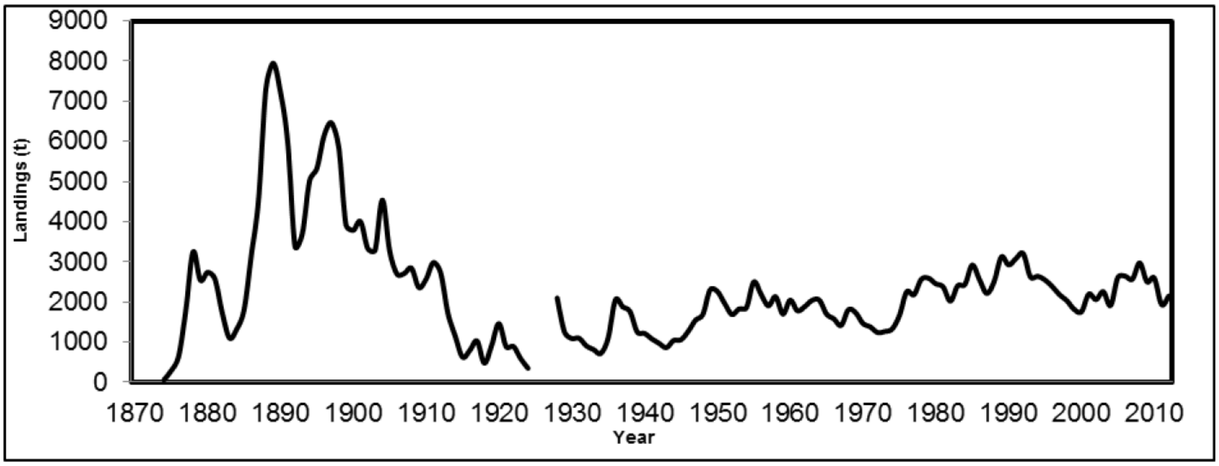

Figure 1. Trends in reported landings for the Newfoundland lobster fishery.

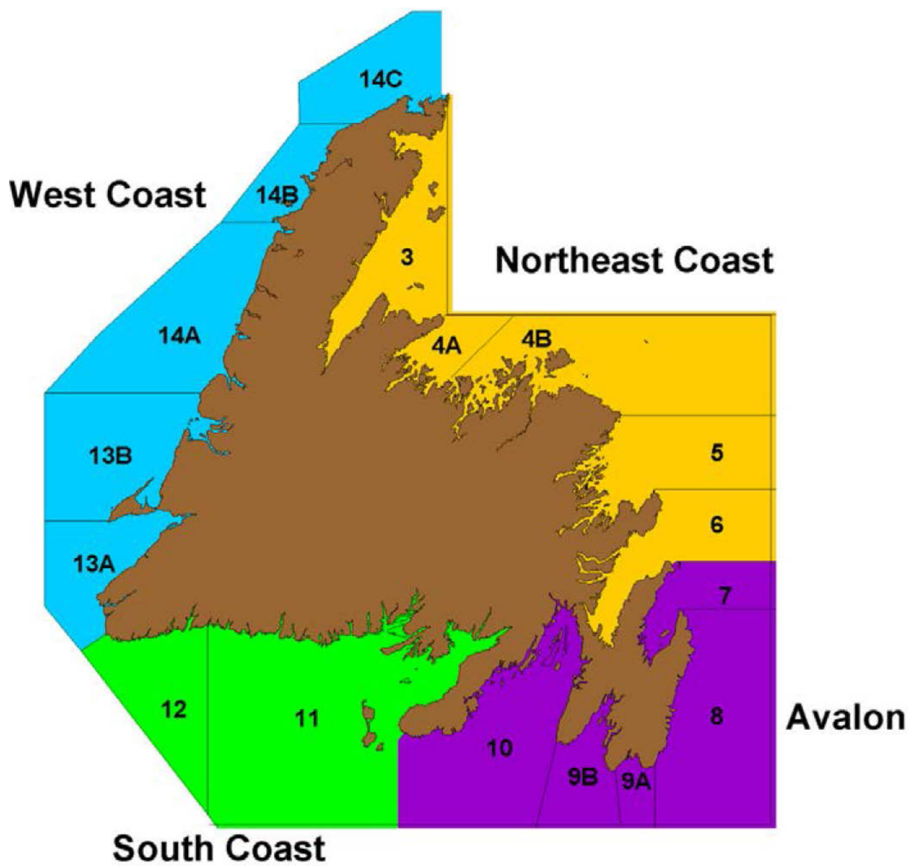

Figure 2. Newfoundland Lobster Fishing Areas (LFAs 3-14) combined into assessment regions.

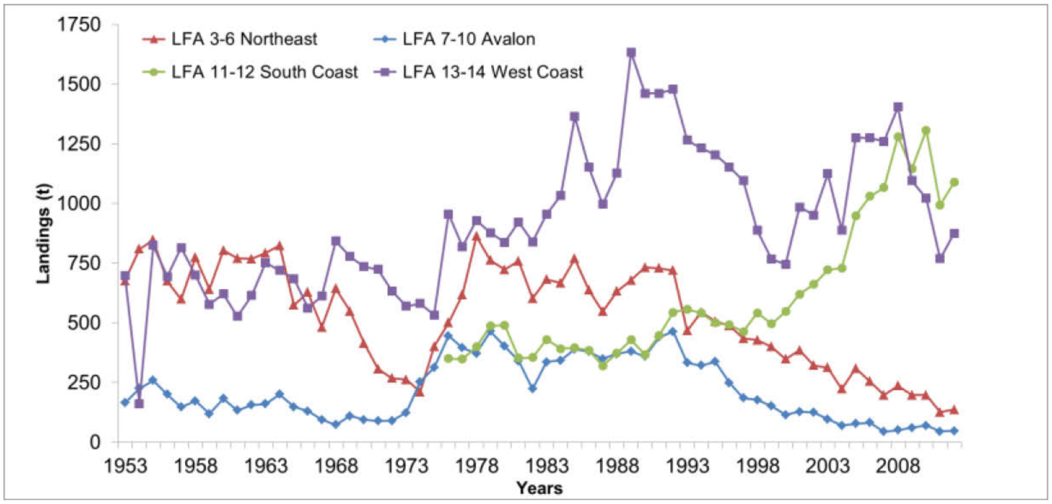

Figure 3. Trends in reported landings for the lobster fishery in each region.

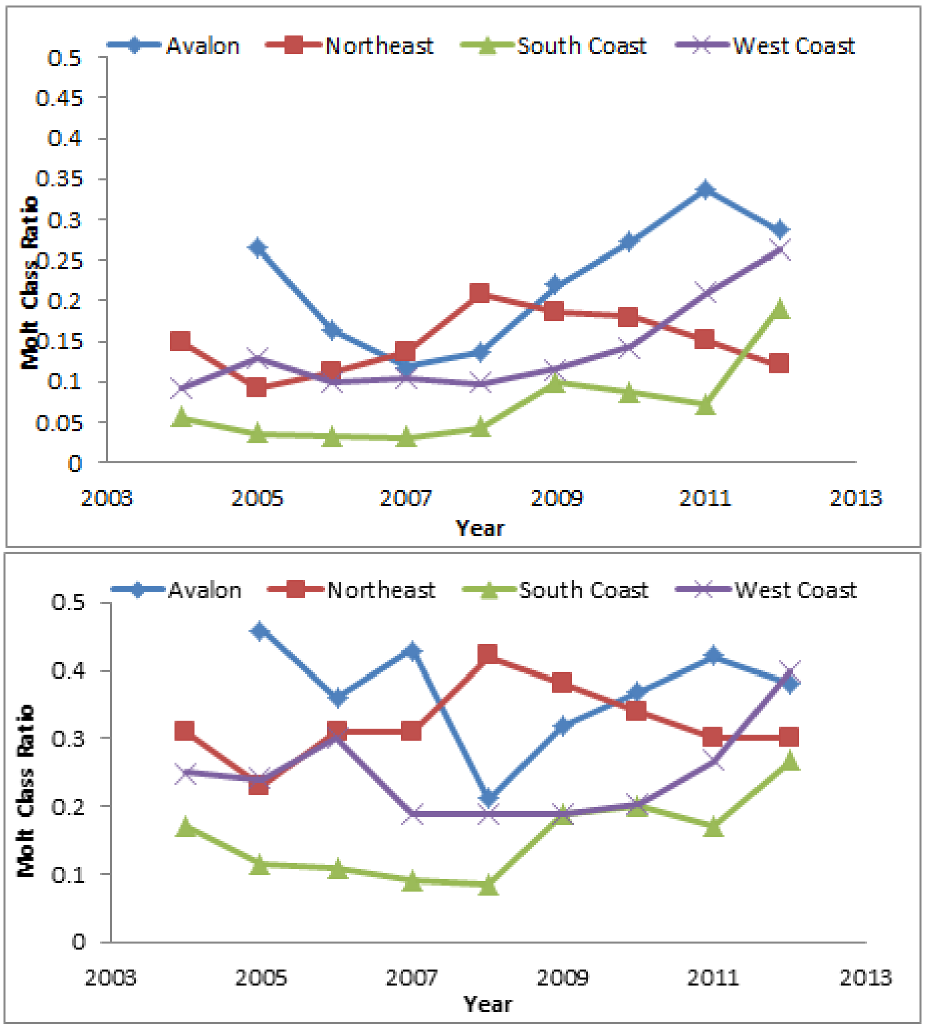

Figure 4. Molt class ratio for males (top) and females (bottom) for each region from 2004 to 2012.

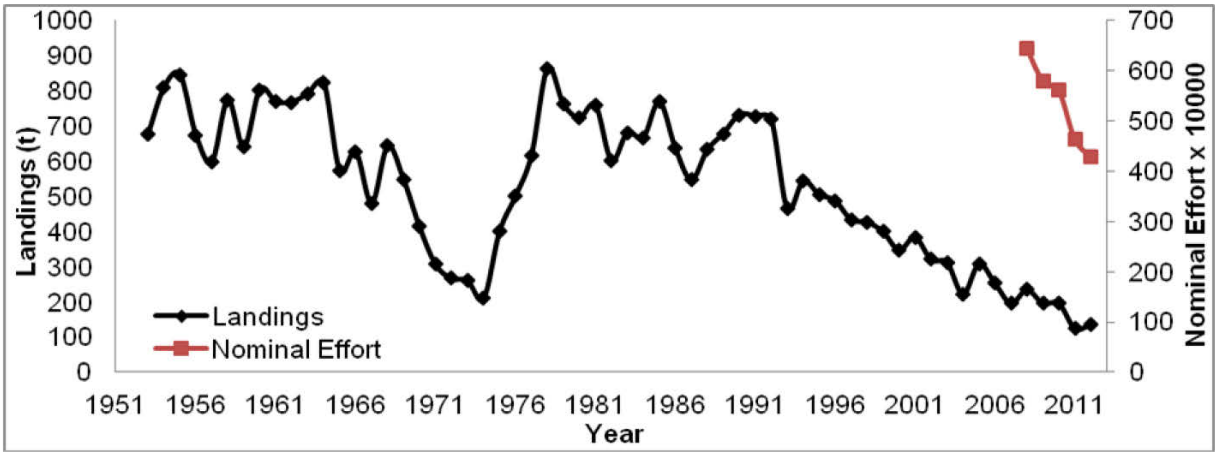

Figure 5. Trends in reported landings and nominal effort in the Northeast region.

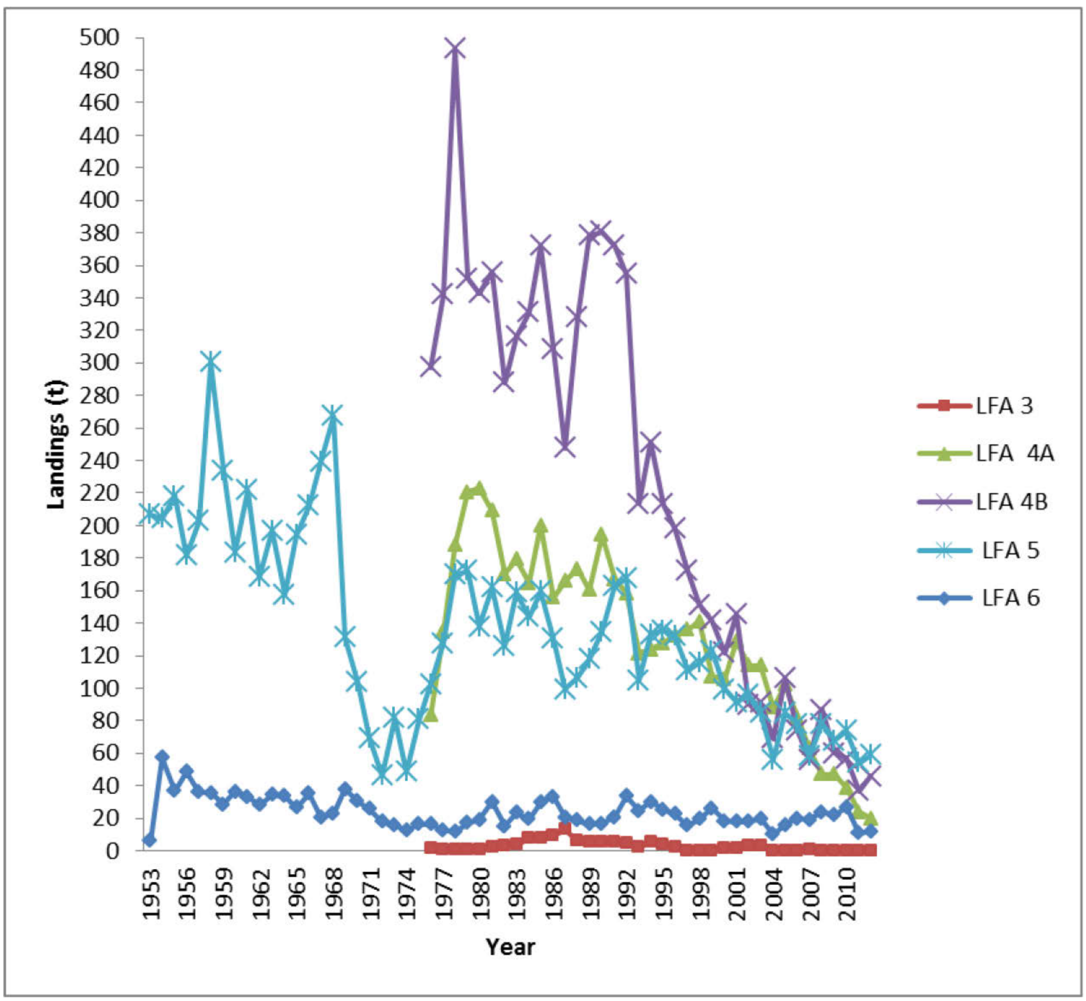

Figure 6.Trends in reported landings for LFAs 3-6 in the Northeast region.

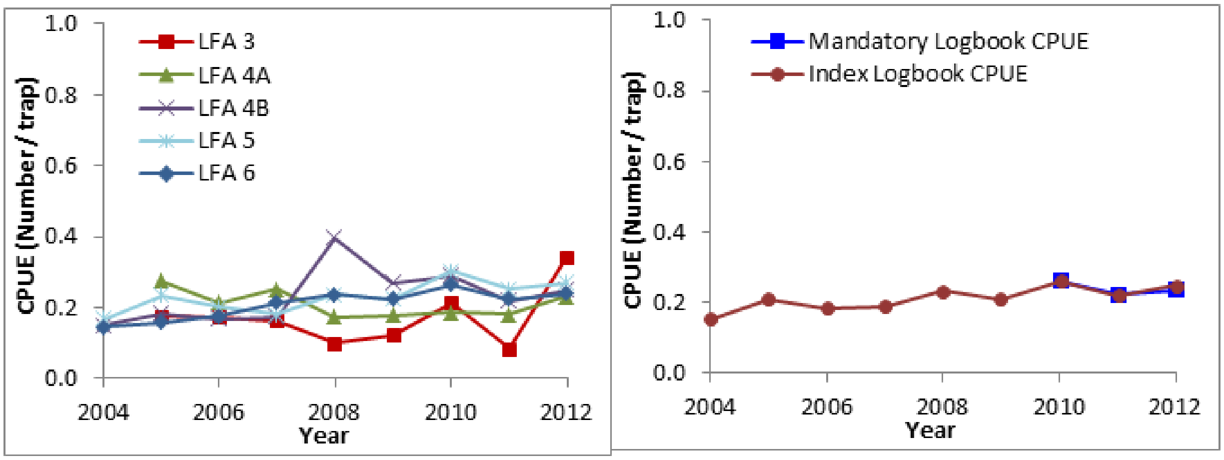

Figure 7. Mean CPUE from Index Fishers Logbooks for LFAs 3-6 and the entire Northeast region, as well as mean CPUE from Mandatory Logbooks for the entire Northeast region (right panel).

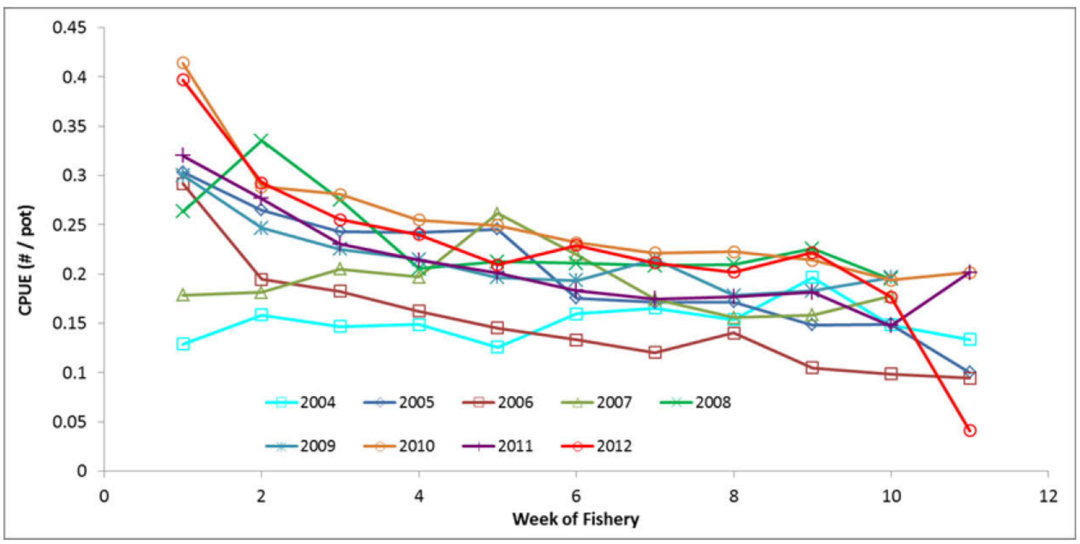

Figure 8. Weekly CPUE from Index Fishers Logbooks in the Northeast region.

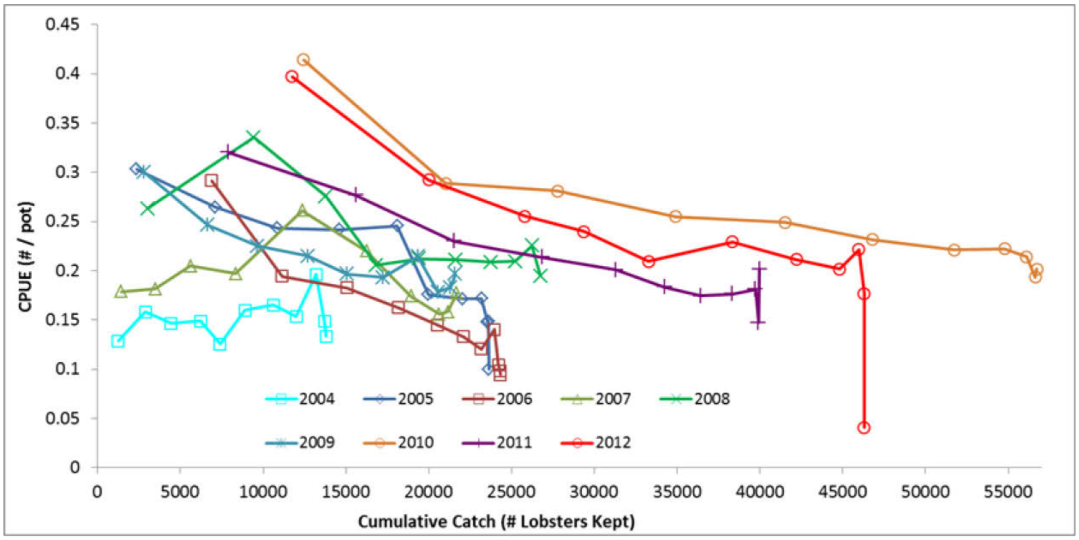

Figure 9. CPUE and cumulative catch from Index Fishers Logbooks for the Northeast region.

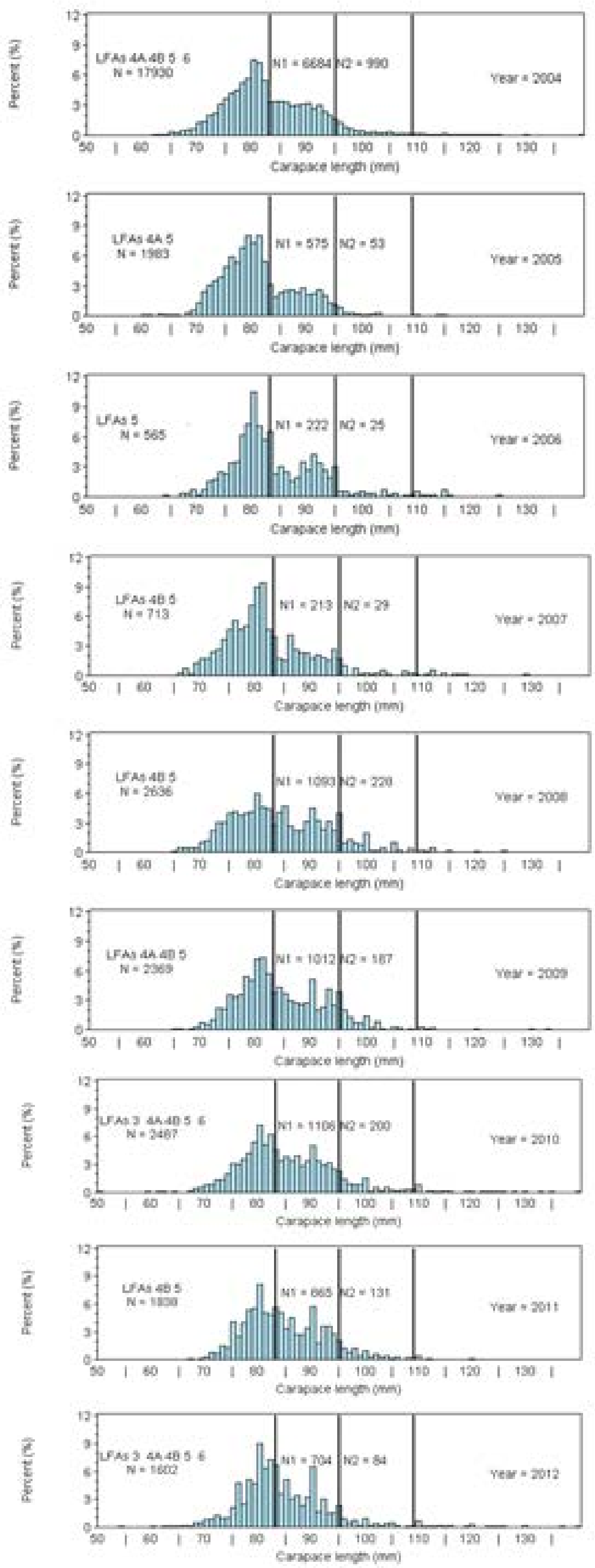

Figure 10. Size frequency distributions from 2004-12 for males in the Northeast region.

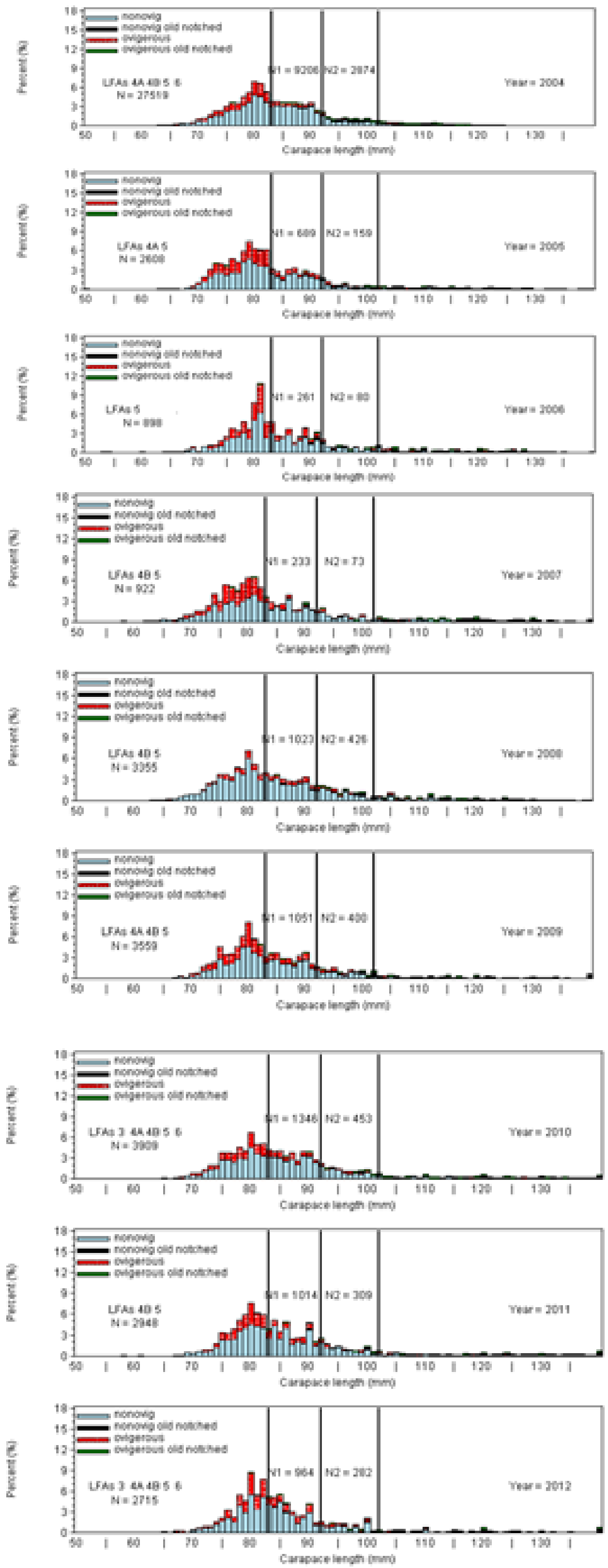

Figure 11. Size frequency distributions from 2004-12 for females in the Northeast region.

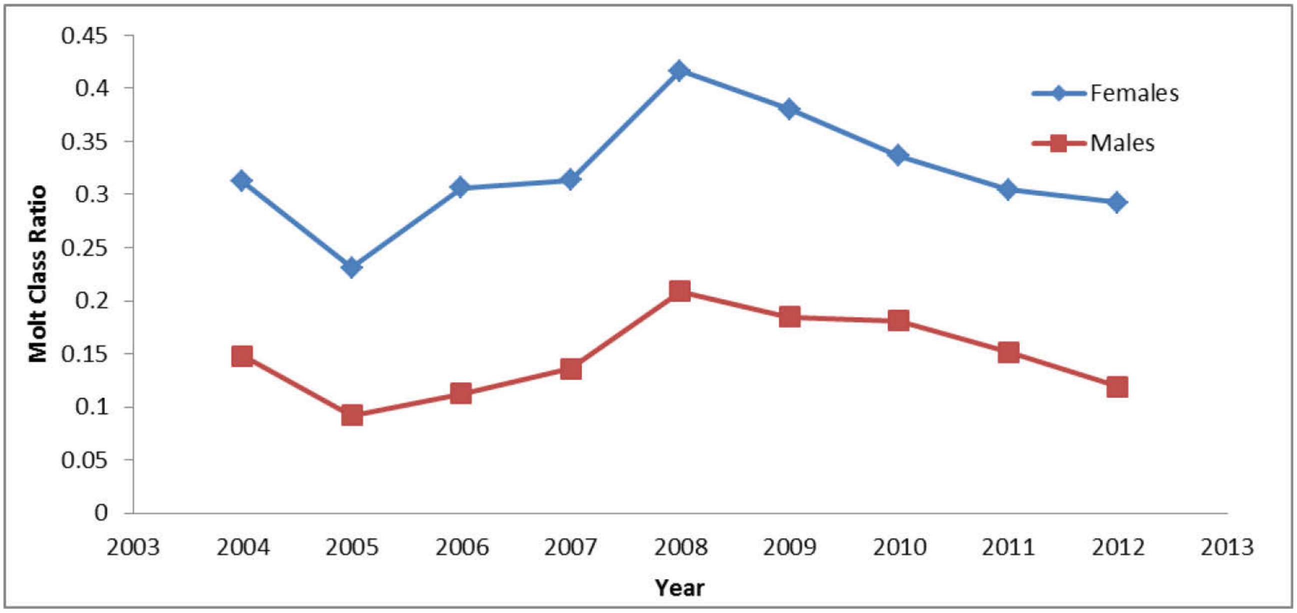

Figure 12. Molt class ratio for males and females in the Northeast region from 2004 to 2012.

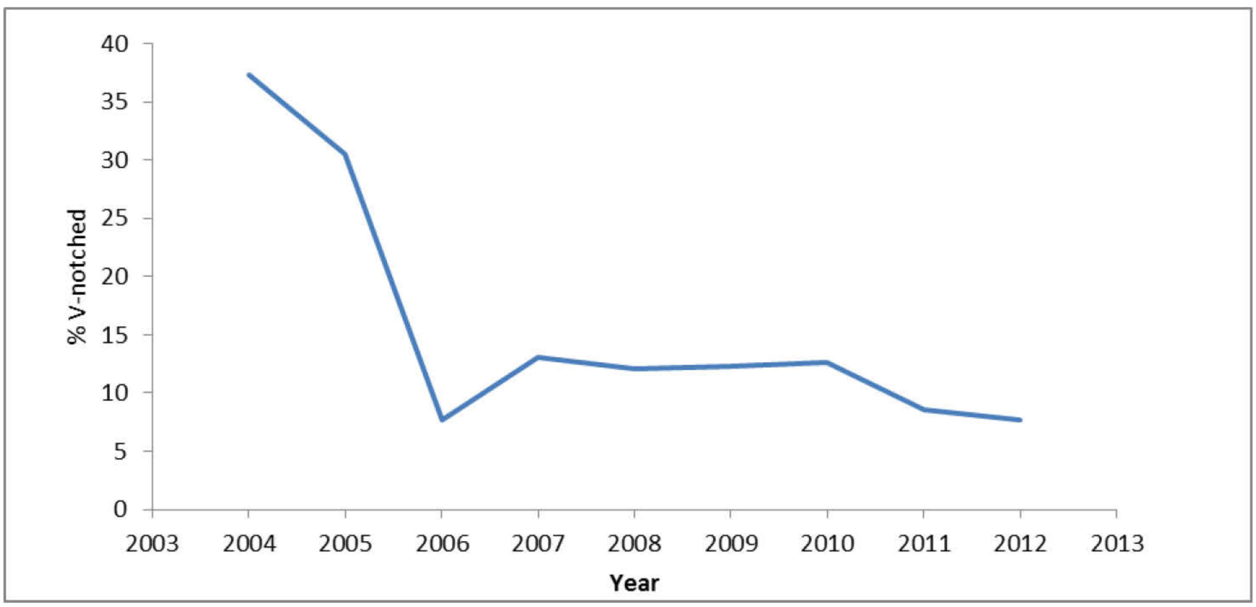

Figure 13. Percentage of v-notching (based on the index fisher logbook data) in the Northeast region from 2004-12.

Figure 14. Trends in reported landings and nominal effort in the Avalon region.

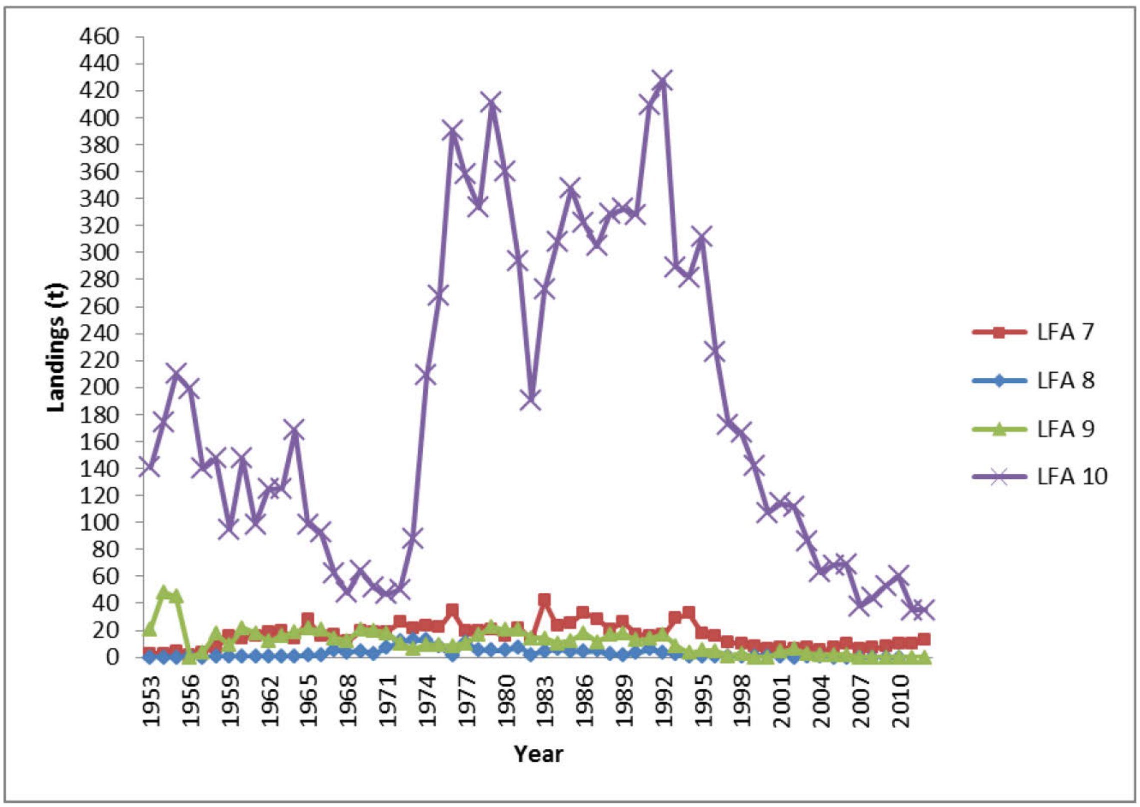

Figure 15. Reported landings for LFAs 7-10 in the Avalon region.

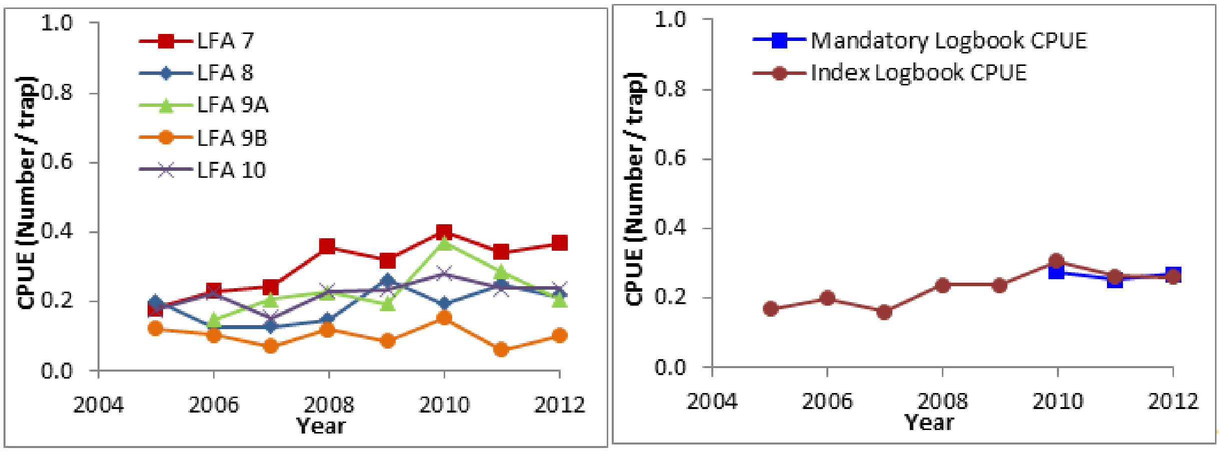

Figure 16. Mean CPUE from Index Fishers Logbooks for LFAs 7-10 and the entire Avalon region, as well as mean CPUE from Mandatory Logbooks for the entire Avalon region (right panel).

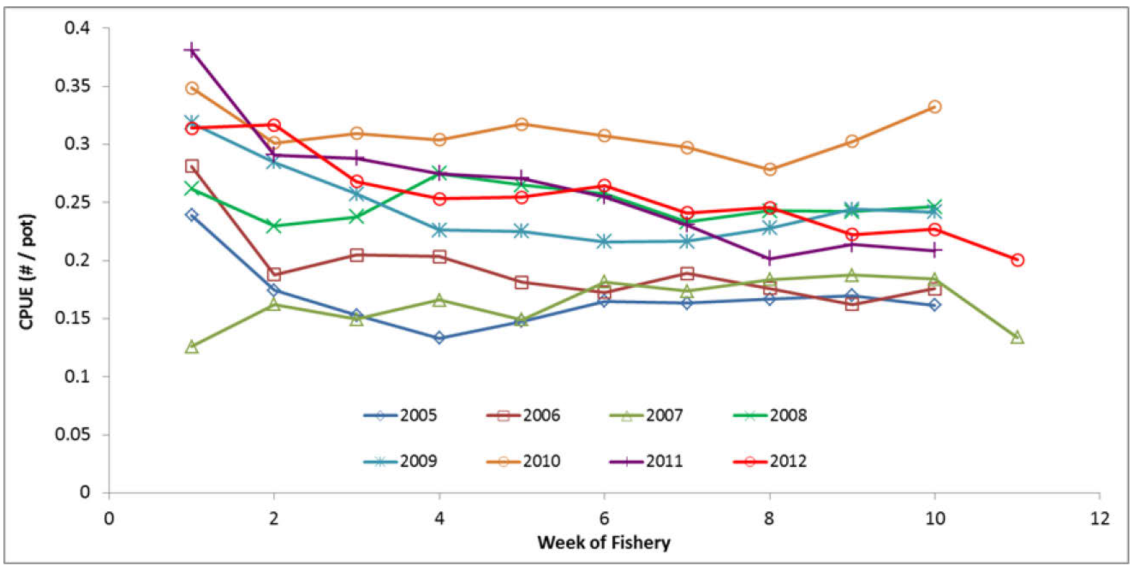

Figure 17. Weekly CPUE from Index Fishers Logbooks for the Avalon region.

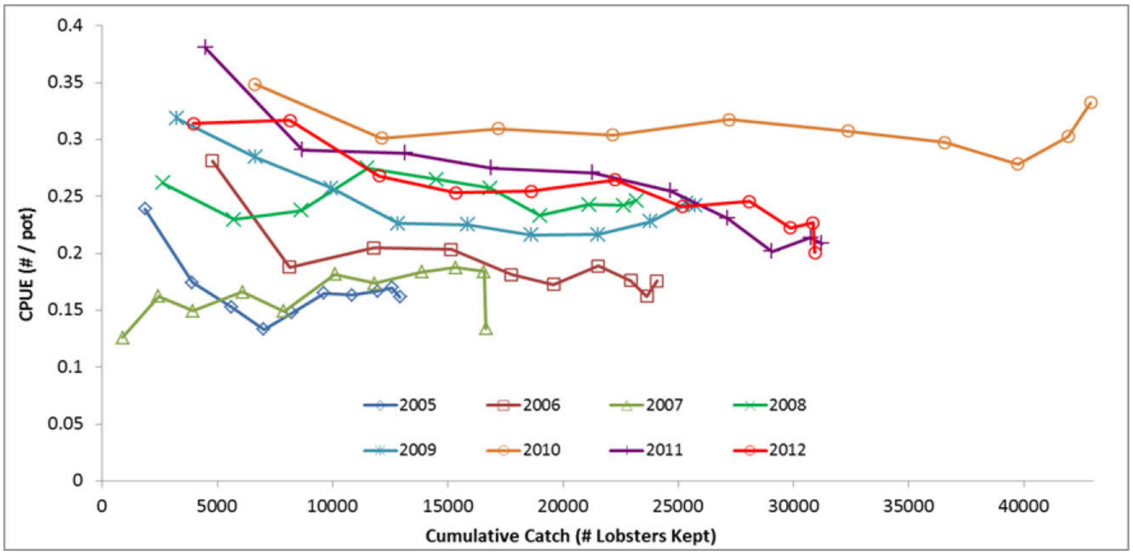

Figure 18. CPUE and cumulative catch from Index Fishers Logbooks for the Avalon region.

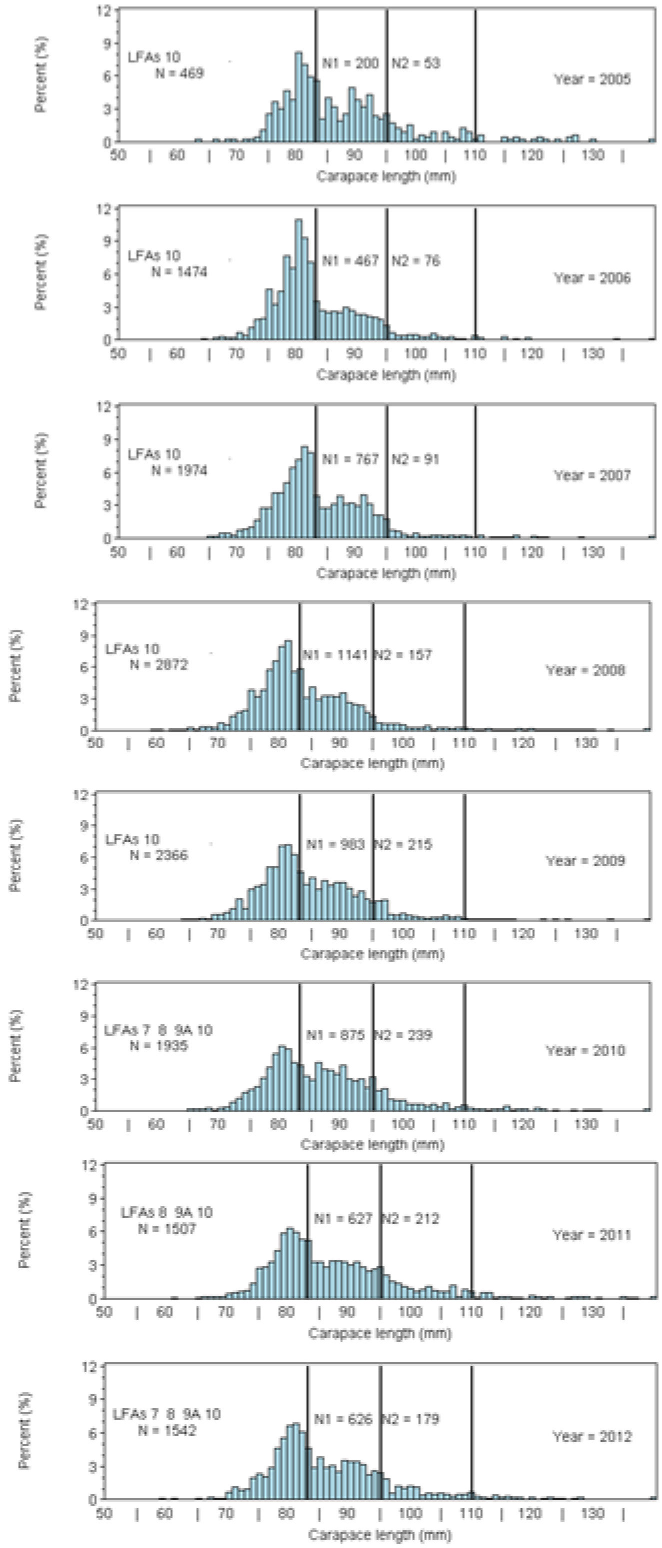

Figure 19. Size frequency distributions from 2004-12 for males within the Avalon Region.

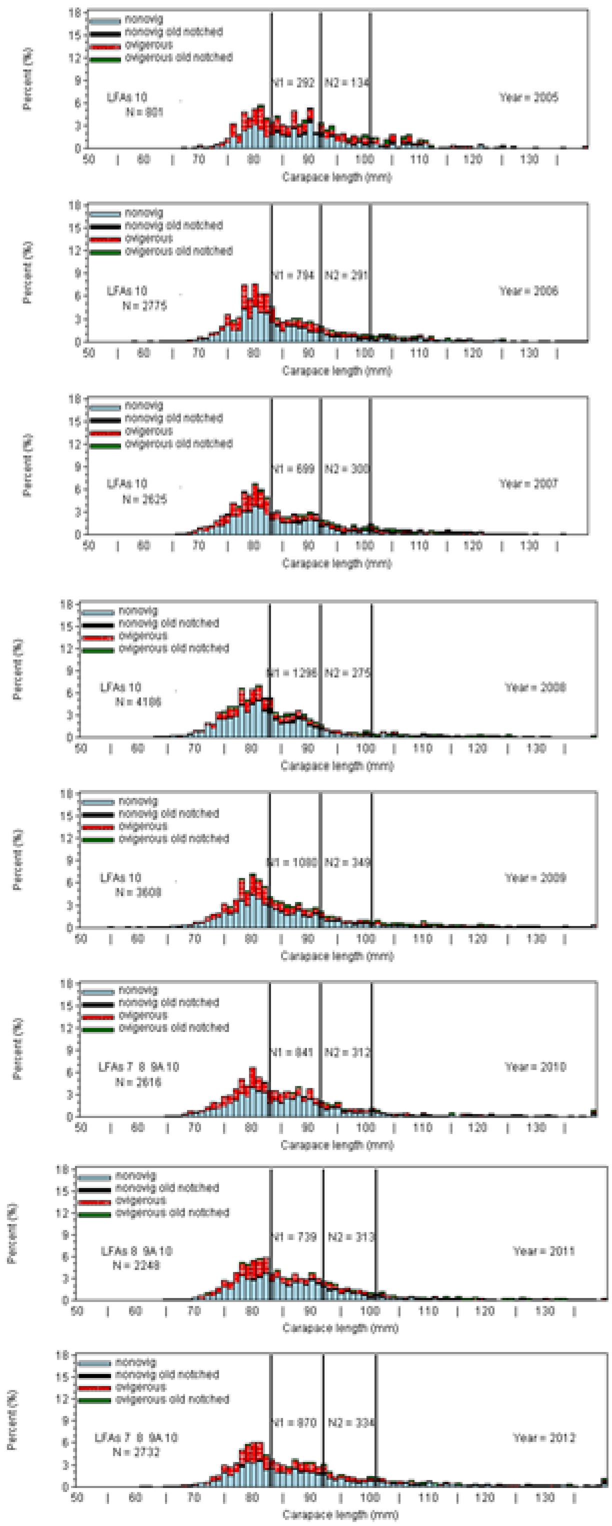

Figure 20. Size frequency distributions from 2004-12 for females within the Avalon Region.

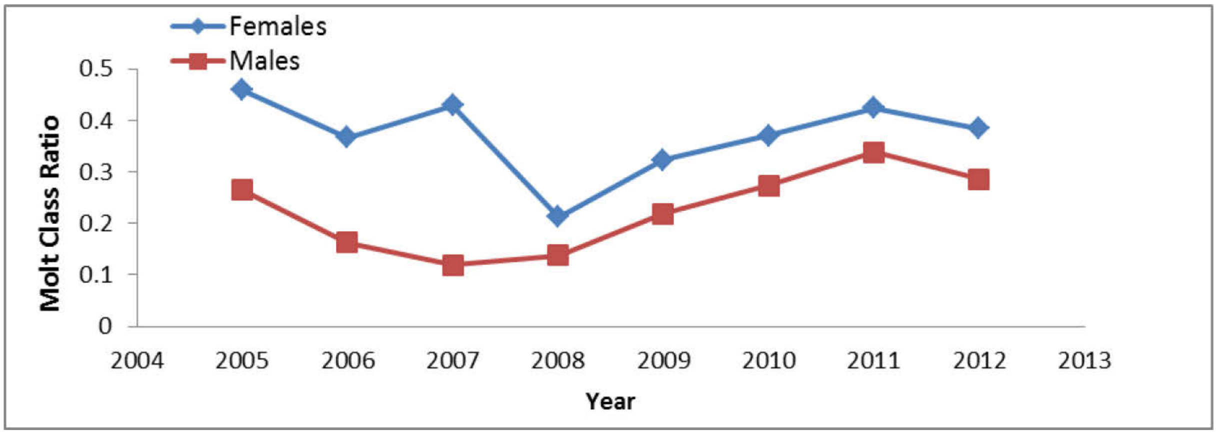

Figure 21. Molt class ratios for male and female lobsters in the Avalon region from 2005 to 2012.

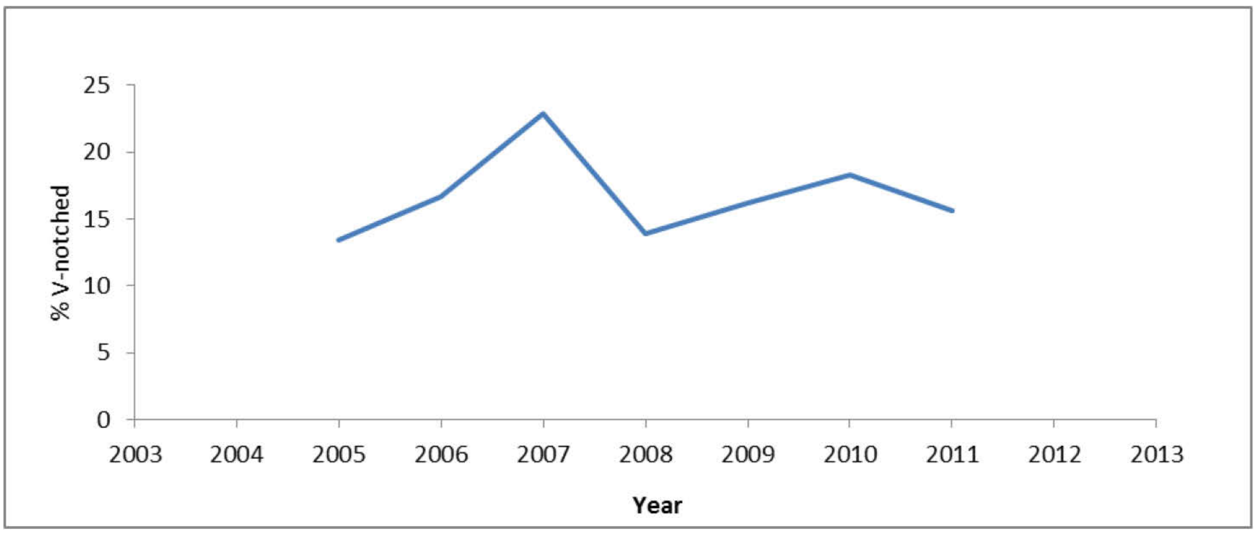

Figure 22. Percentage of V-notching (based on the index fisher logbook data) in the Avalon region from 2004 to 2012.

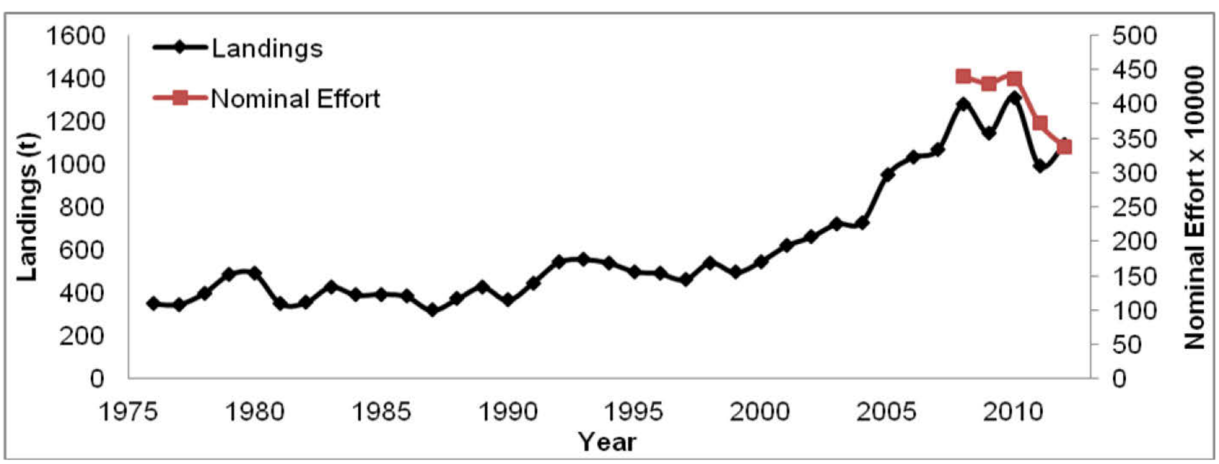

Figure 23. Trends in reported landings and nominal effort in the South Coast region.

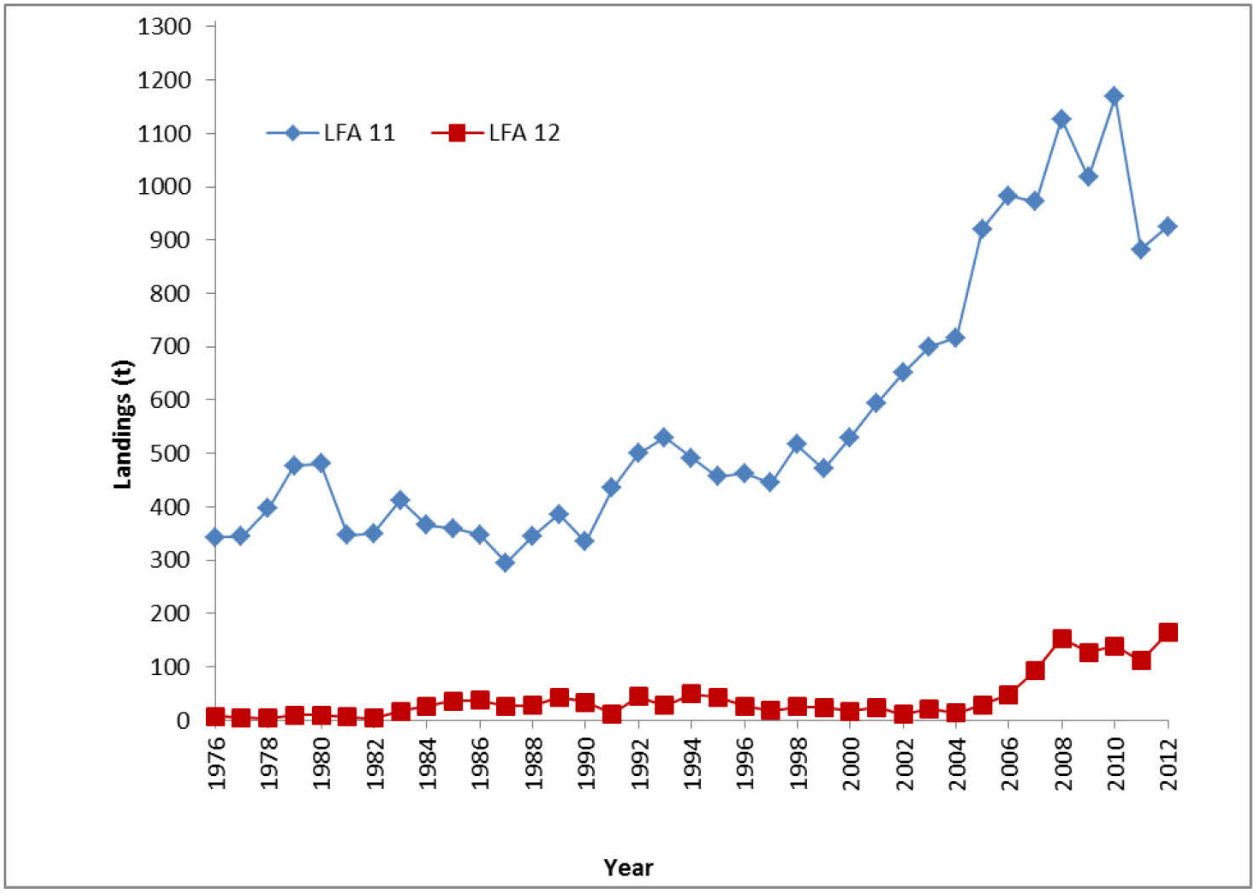

Figure 24. Reported landings for LFAs 11 and 12 in the South coast region

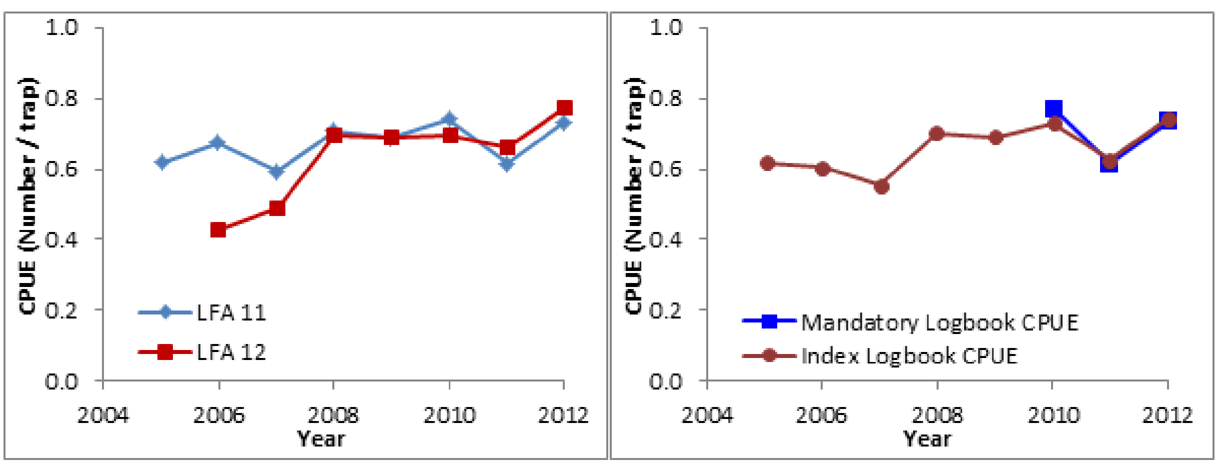

Figure 25. Mean CPUE from Index Fishers Logbooks for LFAs 11-12 and the entire South Coast region, as well as mean CPUE from Mandatory Logbooks (right panel) for the entire South Coast region.

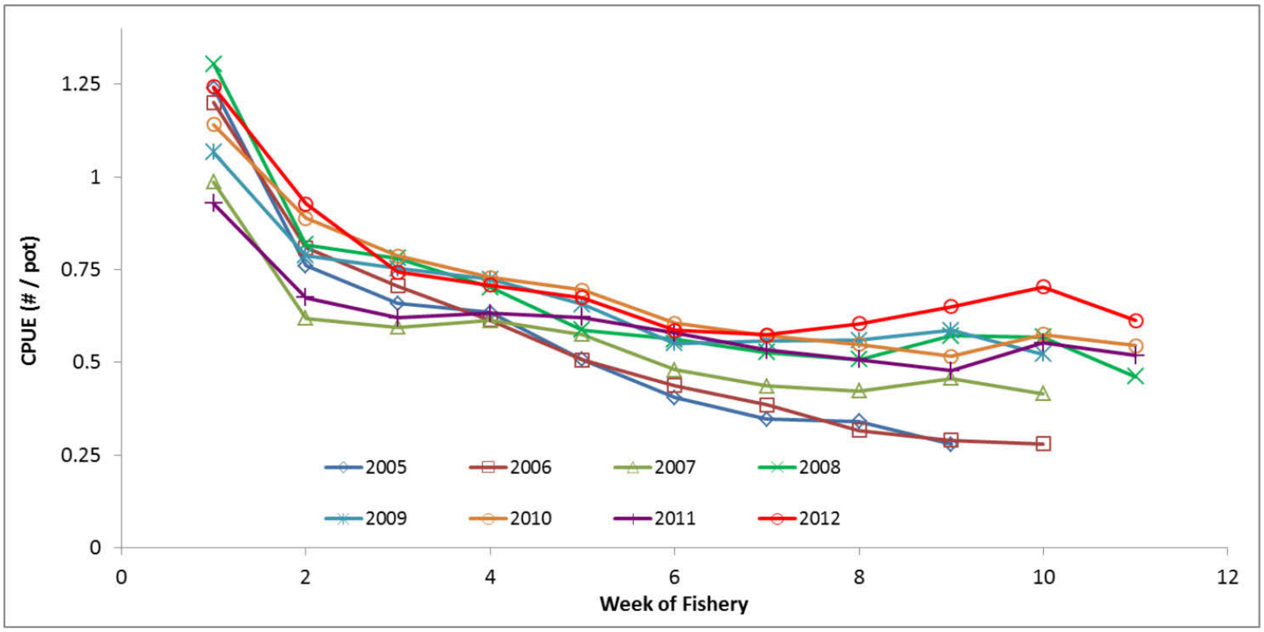

Figure 26. Weekly CPUE from Index Fishers Logbooks for the South coast region.

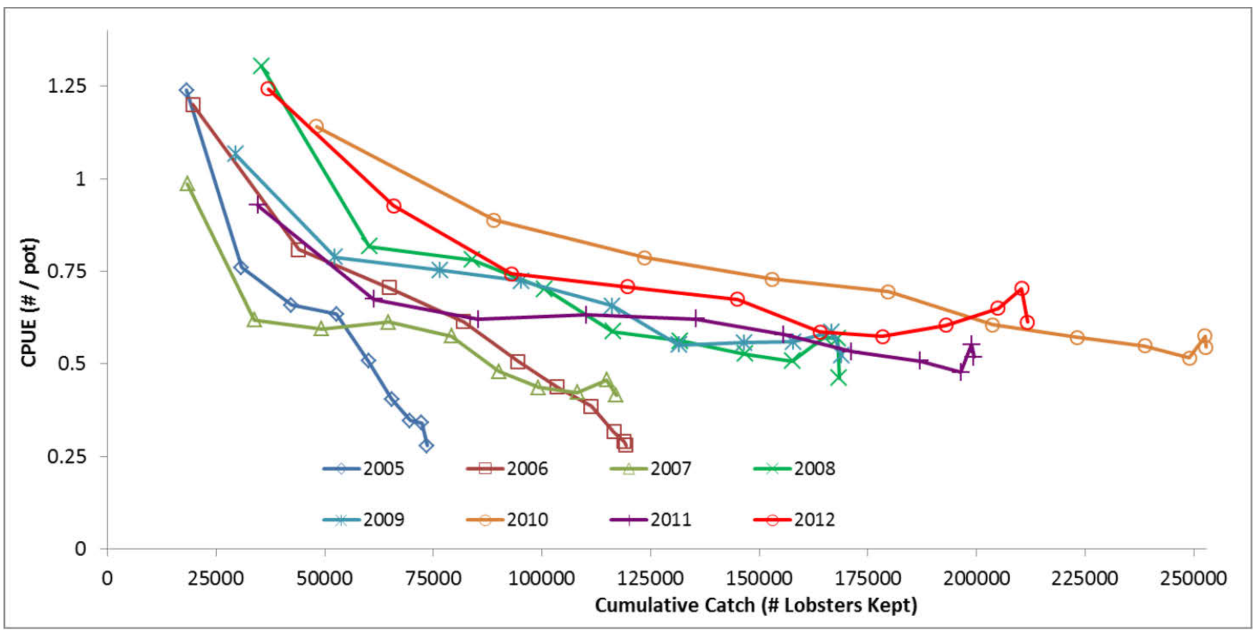

Figure 27. CPUE and cumulative catch from Index Fishers Logbooks for the South coast region.

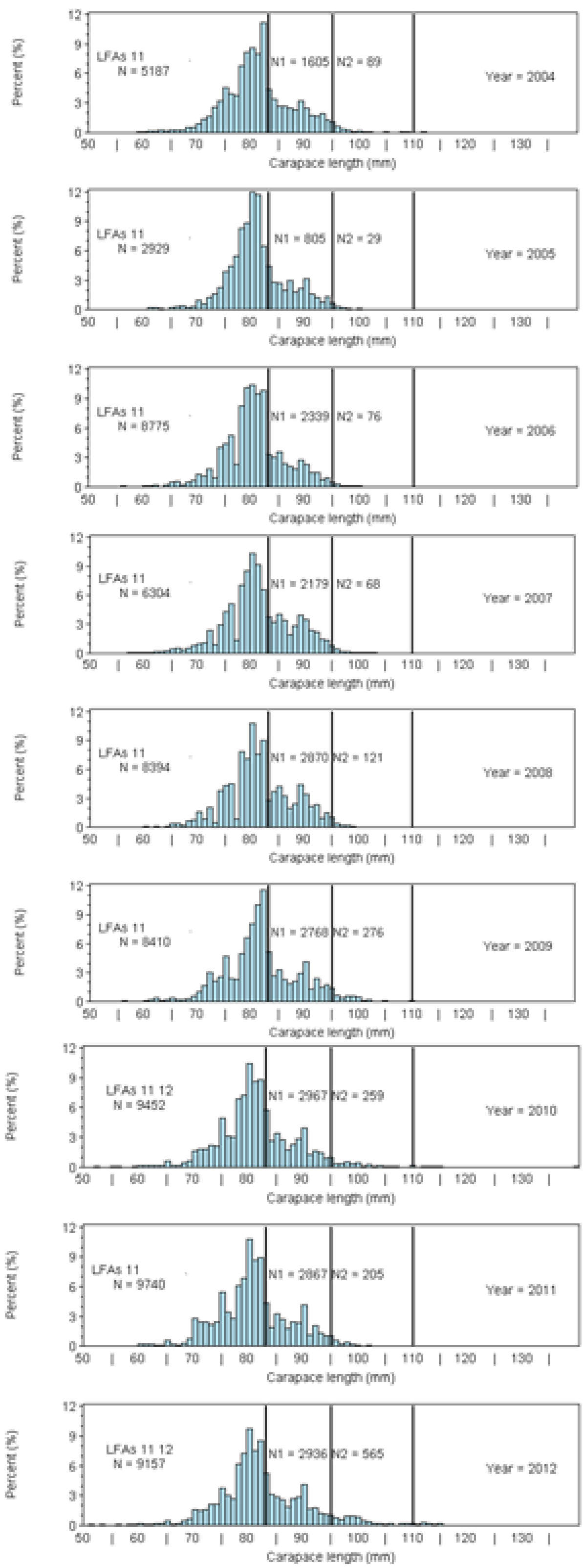

Figure 28. Size frequency distributions from 2004-12 for males within the South Coast Region.

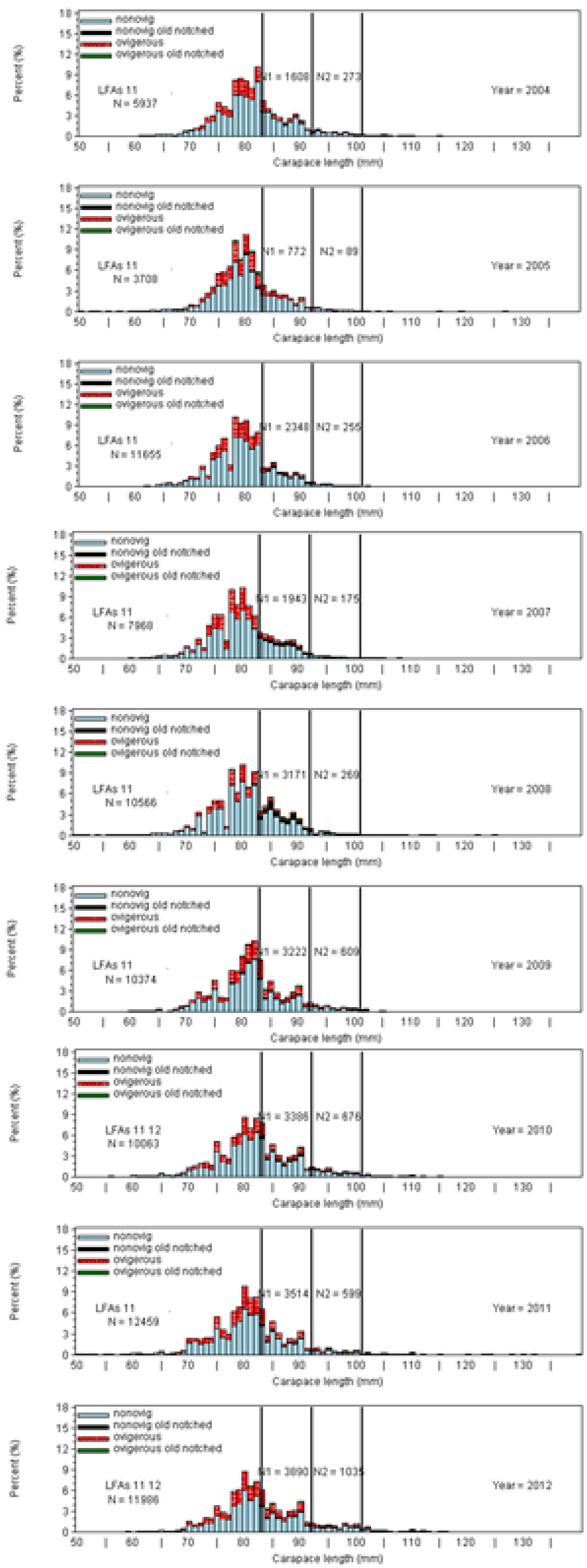

Figure 29. Size frequency distributions from 2004-12 for females in the South Coast Region.

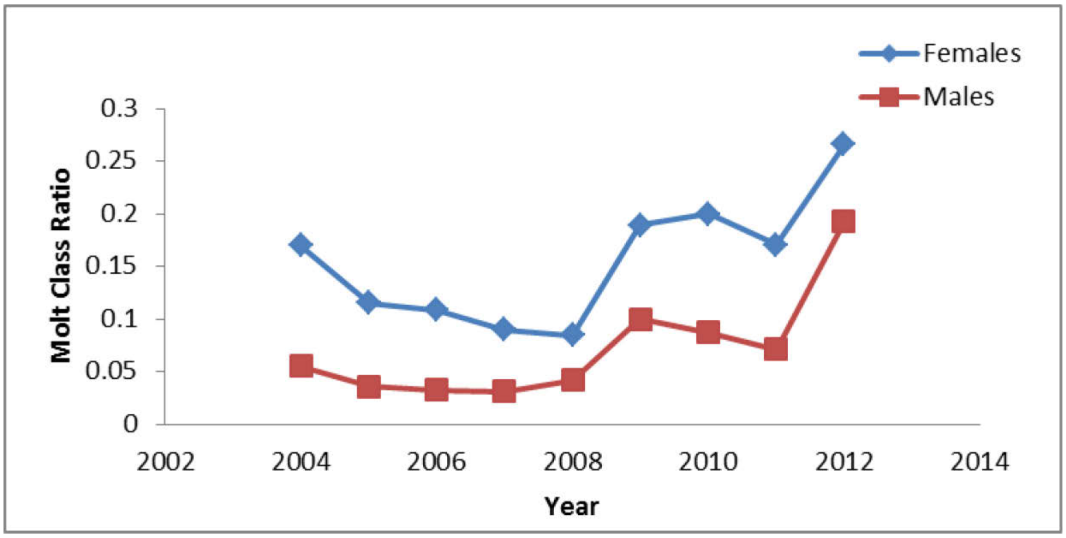

Figure 30. Molt class ratios for male and female lobsters in the South Coast region from 2004 to 2012.

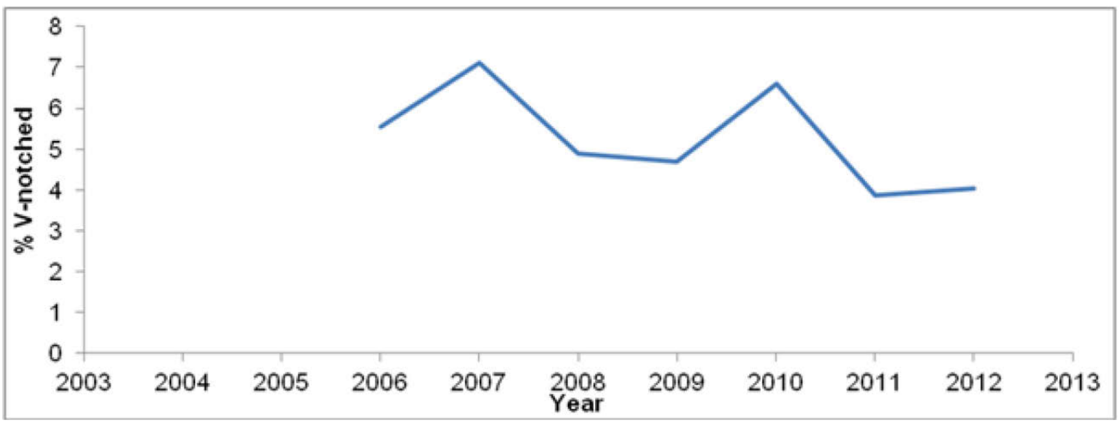

Figure 31. Percentage of V-notching (based on the index fisher logbook data) in the South Coast region from 2006 to 2012.

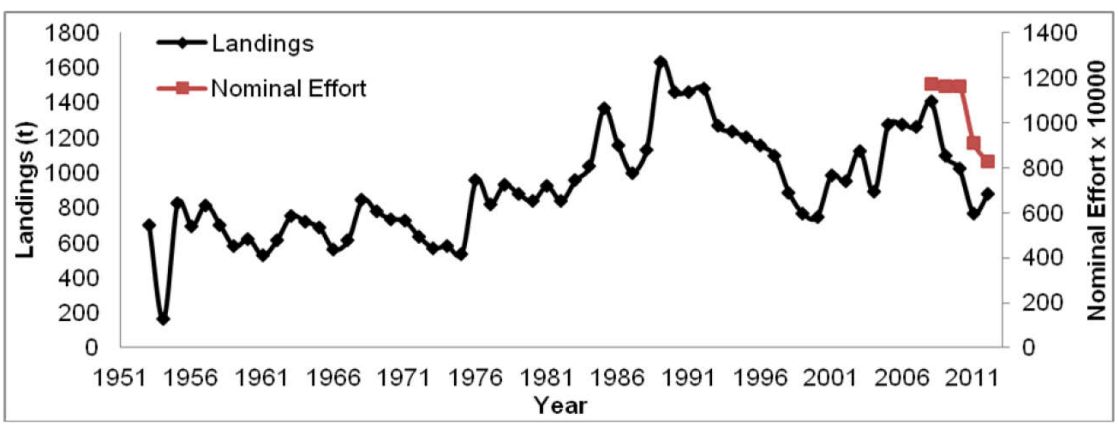

Figure 32. Trends in reported landings and nominal effort in the West Coast region.

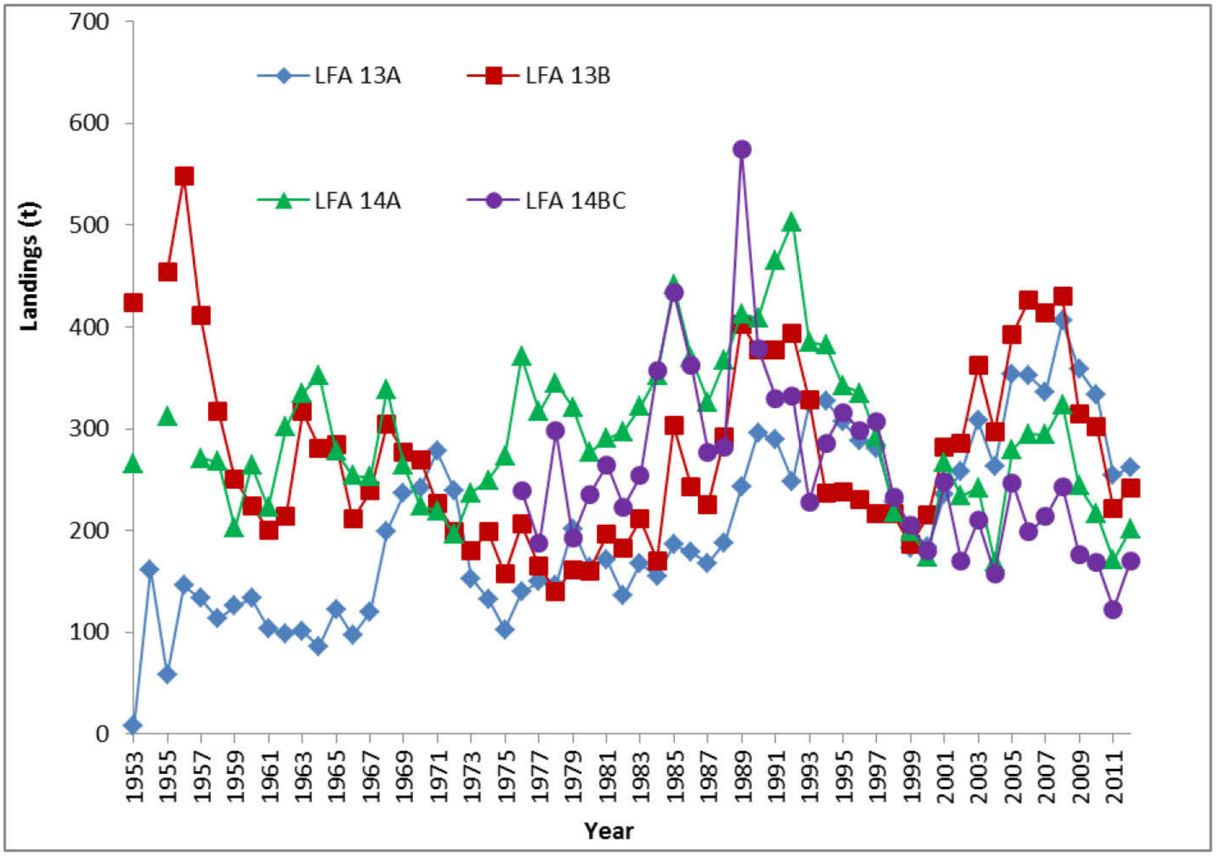

Figure 33. Reported landings for LFAs 13-14BC in the West coast region.

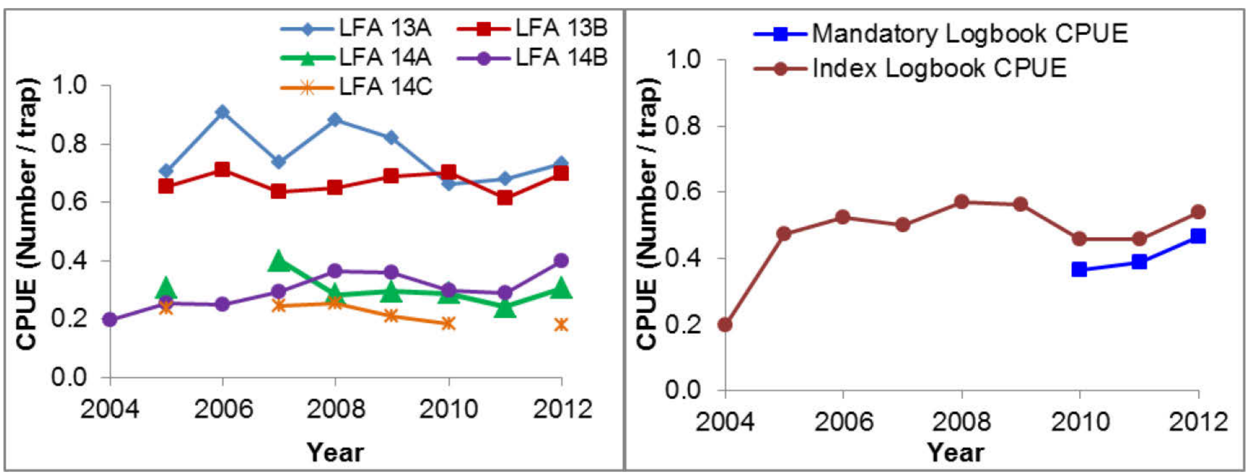

Figure 34. Mean CPUE from Index Fishers Logbooks for LFAs 13-14 and the entire West Coast region, as well as mean CPUE from Mandatory Logbooksfor the West Coast region (right panel).

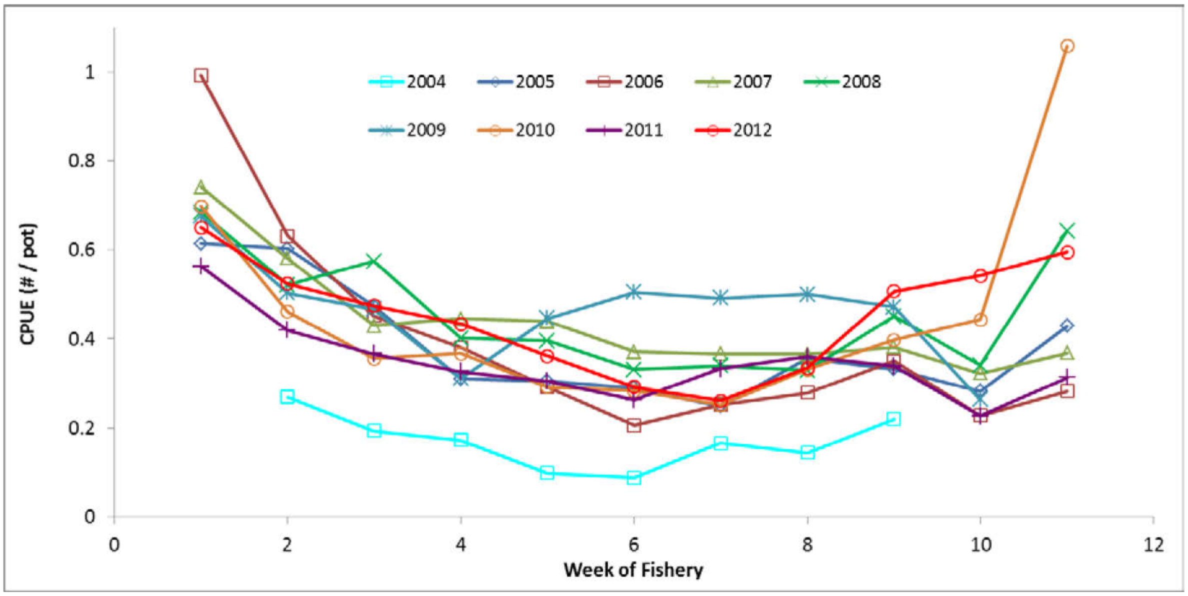

Figure 35. Weekly CPUE from Index Fishers Logbooks for the West coast region.

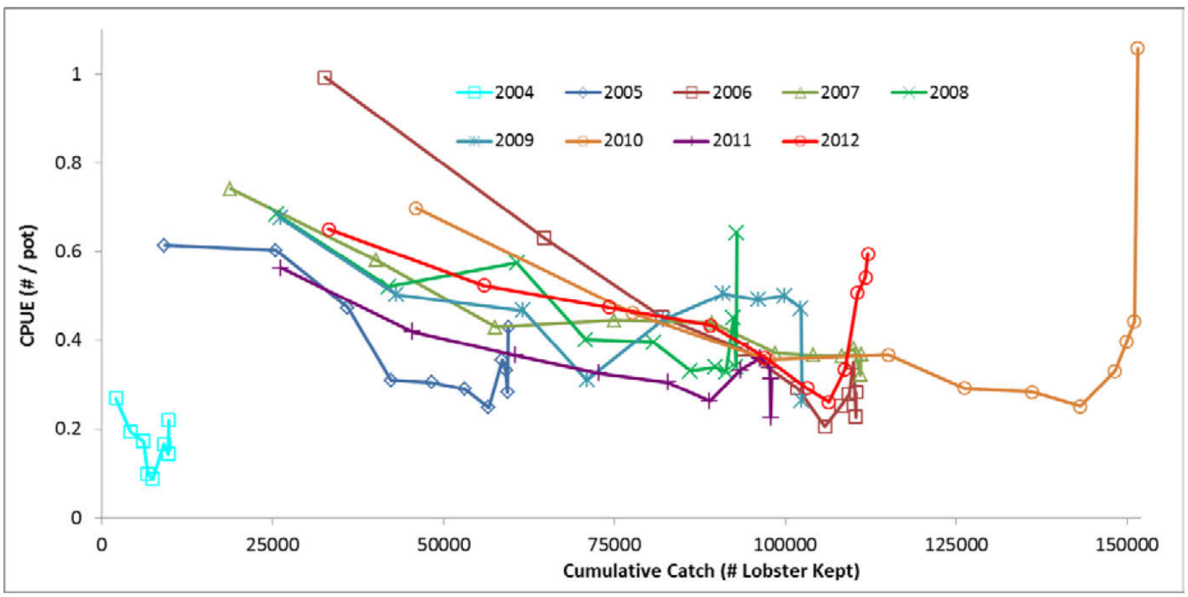

Figure 36. CPUE and cumulative catch from Index Fishers Logbooks for the West coast region.

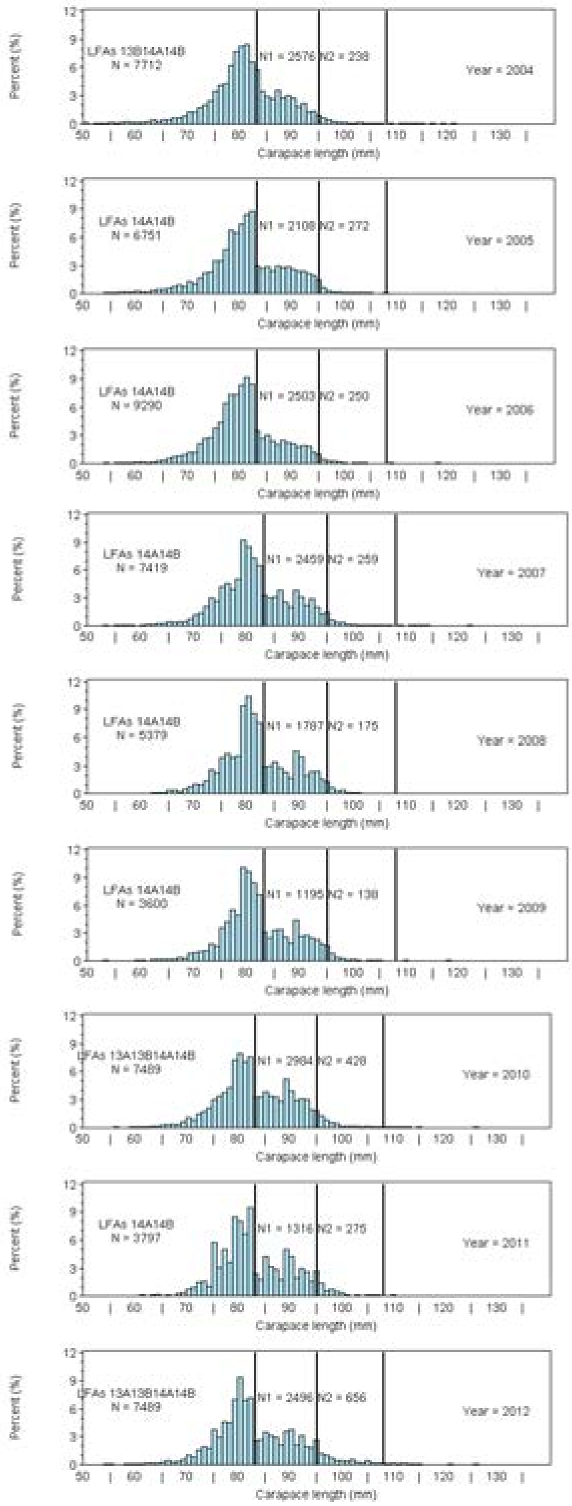

Figure 37. Size frequency distributions from 2004-12 for males within the West Coast Region.

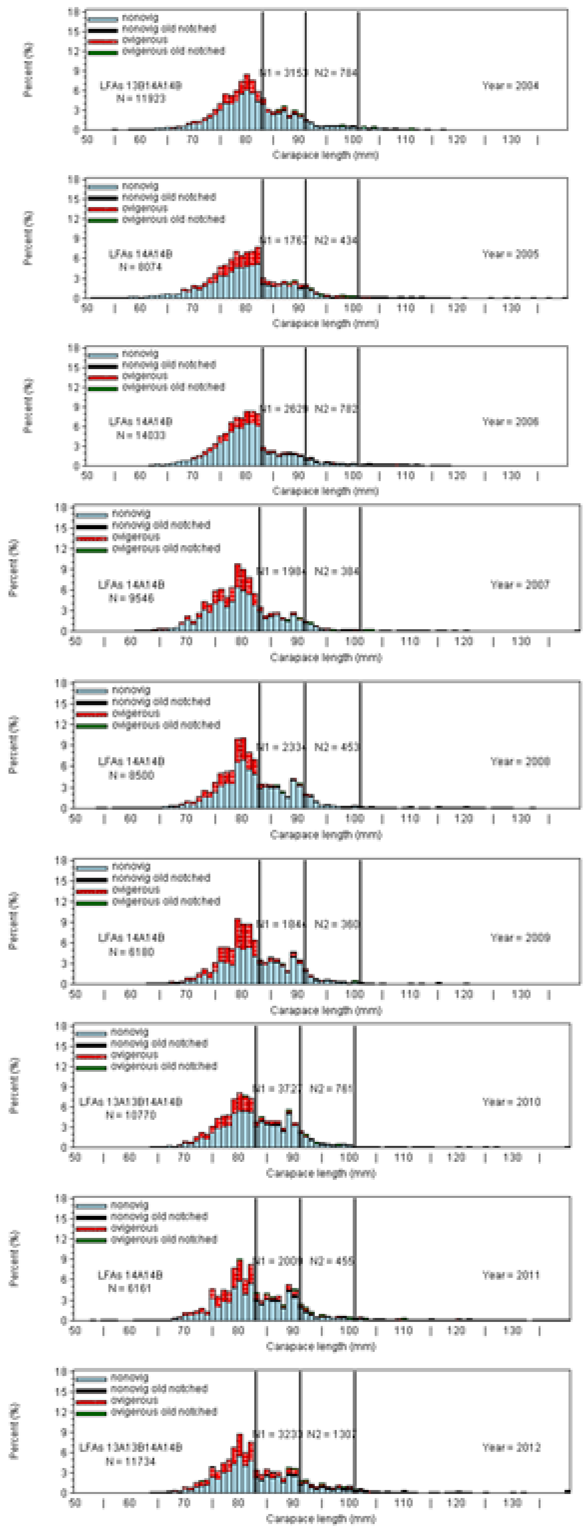

Figure 38. Size frequency distributions from 2004-12 for females in the West Coast Region.

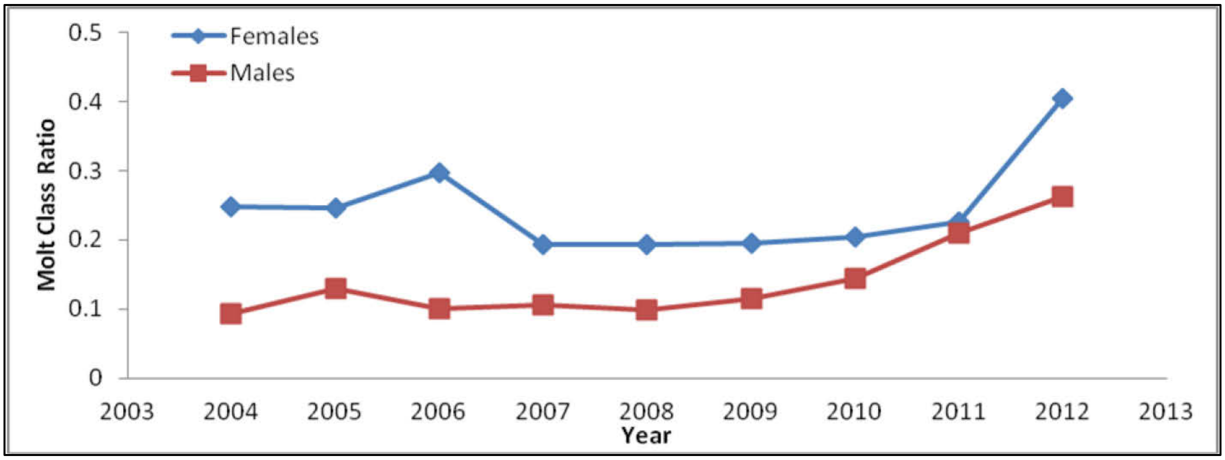

Figure 39. Molt class ratios for male and female lobsters in the West Coast region from 2004 to 2012.

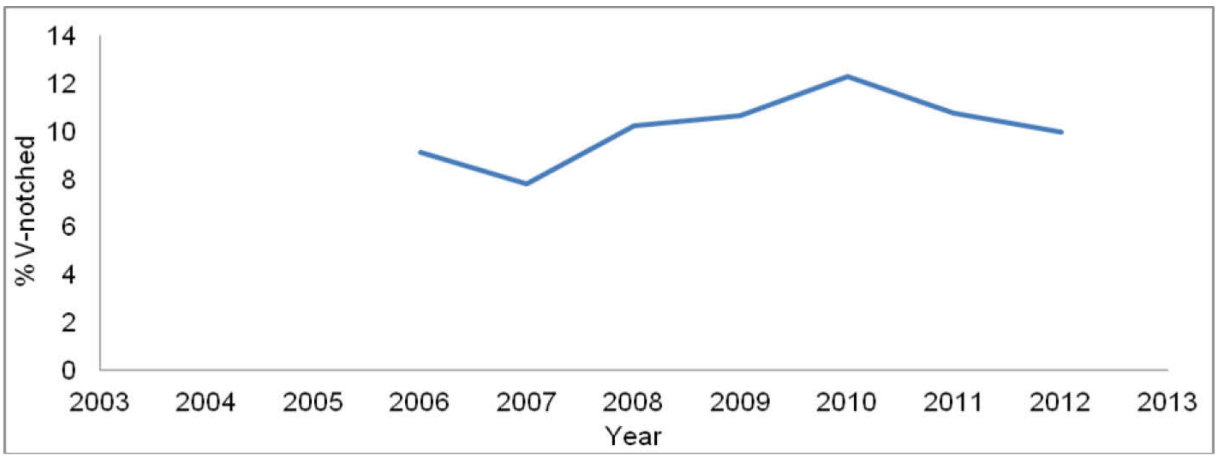

Figure 40. Percentage of V-notching (based on the index fisher logbook data) in the West Coast region from 2006 to 2012.